THE ROLE OF THE NETWORK LEAD COMPANY IN INTEGRATING NEW PRODUCT DEVELOPMENT PROCESSES ACROSS STRATEGIC PARTNERS

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This PhD thesis is dedicated to

my mother

and

the memory of my father

Abstract

In today's network world, advancement in new product development (NPD) is being driven by different types of networks, joint ventures, alliances, outsourcing and mergers. These business trends have resulted in complex organisations and development projects that cross location, company, country and cultural boundaries. The key success is no longer integrating the company's units and activities, but integrating the NPD process across a network of strategic partners. Managing the integration of an NPD process in this increased organisational complexity requires a sophisticated organisation design to facilitate and support the coordination of activities and the flow of information across the network.

The research investigates the impact of organisational design of the network lead company (the main company in the network) on the NPD project's integration process elements with external partners and the subsequent effects on performance. The "integration process elements" in this research are: "communication and coordination." I focus on the R&D organisation in the network lead company. Within the R&D organisation, I adopt the project level of analysis and answer the main research question: How can the network lead company design its R&D organisation to support the NPD project's communication and coordination activities with the project strategic partners and improve project performance? The research centres on the integration with strategic partners in whom the network lead company has equity investments (minority holdings).

Using data collected from three in-depth case studies of high-tech NPD projects conducted by three network lead companies from different industries, I attempt to extend and merge the knowledge of NPD management and the organisation theory by proposing a contingency model and developing a condition of fit between contextual conditions that characterise the high-tech NPD project and the organisation design of the network lead company.

The model suggests that the efficient performance of the development project (shortest, cheapest, and highest quality possible) is contingent on how well the **actual** intensity levels of communication and coordination fits the **required** intensity levels. The research also indicates that the **required** intensity of communication and coordination between the network lead company and the project strategic partners in uncertain and complex project is dominated by

the development cycle time (DCT) of the project. Conversely, the **actual** intensity of communication and coordination between the NPD project team of the network lead company and its project strategic partners is enabled by differentiated combination of R&D organisational attributes: centralisation, formalisation, number of hierarchical levels, team empowerment, and power of the leadership.

Keywords: New product development, process integration, organisation design, communication process, coordination process, project performance.

Résumé

Dans le monde d'aujourd'hui, où tout fonctionne de plus en plus en réseau, le progrès, en matière de développement de nouveaux produits (DNP) est généré par différents types de réseaux, de partenaires, d'alliances, de sous-traitance et de fusions. Cette tendance a entraîné une grande complexité des organisations et des projets de développement, qui associent des sites d'implantation, des compagnies, des pays ou encore des cultures distincts. La clé du succès ne consiste plus à intégrer seulement des unités et des activités de l'entreprise, mais à intégrer le processus DNP à travers un réseau de partenaires. Gérer l'intégration d'un processus de développement de nouveaux produits dans ce système organisationnel toujours plus complexe exige un concept d'organisation sophistiqué dont le but est de faciliter et de soutenir la coordination des activités et le flux des informations présentes dans le réseau.

Cette recherche analyse l'impact du modèle d'organisation de la « compagnie leader du réseau » (c'est-à-dire la compagnie pilote dans le réseau) sur l'intégration du processus de développement de nouveaux produits à travers un réseau de partenaires stratégiques. Elle étudie ensuite les effets subséquents sur les performances du projet. Une attention particulière est portée sur l'organisation R&D (recherche et développement) au sein de la compagnie pilote. Dans le cadre de l'organisation R&D, l'étude est menée au niveau du projet et nous répondons à la question centrale de la recherche, à savoir : comment la principale compagnie doit-elle concevoir son organisation R&D pour être en mesure de soutenir de façon efficace les différents éléments du processus d'intégration (communication et coordination) avec ses partenaires stratégiques et améliorer les performances du projet?

Sur la base de trois études de cas approfondies de projets DNP dans le domaine de la technologie de pointe, nous avons développé un modèle synthétisant le savoir-faire et les connaissances en matière de gestion DNP et de théorie organisationnelle. Ainsi, nous proposons un modèle qui explicite les caractéristiques et les conditions contextuelles qui caractérisent d'une part le projet DNP dans le domaine de la technologie de pointe ainsi que le concept organisationnel idoine de la compagnie principale au sein du réseau d'autre part.

Ce modèle montre que la performance réelle du projet de développement (plus rapide, plus avantageux, de meilleure qualité) dépend du degré d'efficacité avec lequel les niveaux d'intensité **réels** de la communication et de la coordination correspondent aux niveaux d'intensité **requis**. La notion d'intensité requise par rapport à l'intensité réelle dépend de nombreux facteurs qui sont passés systématiquement en revue. La recherche démontre également que l'intensité de communication et de coordination **requise** entre la compagnie principale au sein du réseau et ses partenaires stratégiques, dans le cadre de projets complexes et incertains, est directement influencée par la durée du cycle de développement (DCD) du projet. Inversement, l'intensité **réelle** de la communication et de la coordination entre l'équipe du projet DNP de la compagnie principale et ses partenaires stratégiques dépend étroitement des différentes combinaisons de R&D et de fonctions organisationnelles: centralisation, formalisation, nombre d'échelons hiérarchiques, pouvoir de l'équipe en charge et pouvoir des responsables.

Mots clés: développement de nouveaux produits, intégration du processus, concept organisationnel, processus de communication, processus de coordination, performances du projet.

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Abbreviations

BoD	Board of Directors
BU	Business Unit
CEO	Chief Executive Officer
CPM	Critical Path Method
CSP	Cost, Schedule, and Performance
DCT	Development Cycle Time
DDS	Discovery and Development Services
DPD	Development Planning Director
EMB	Executive Management Board
FDA	Food and Drug Administration
GEC	General Executive Committee
GO	Group Optimisation
NPD	New Product Development
ODM	Original Design Manufacturer
OEM	Original Equipment Manufacturer
ORA	Oxytocin Receptor Antagonist
PAD	Product Availability Date
PDPI	Product Development Process Improvement
PL	Product Line
PLSG	Product Line Strategy Group
PMIS	Project Management Information System
R&D	Research and Development
RH	Reproductive Health
RBV	Resource Based View
SFE	Strategic Front End

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1 Introduction and problem statement

1.1 Introduction

The current new product development (NPD) climate is characterised by increased domestic and global competition; increasingly shorter technological development waves; continuous development of new technologies that make existing products obsolete; changing customer requirements that shorten product life cycles; and rising product development costs (Cooper, 1994; Gupta & Wilemon, 1990). The environment for NPD in most technologically advanced industries suggests that the complexities and uncertainties associated with technology-intensive “high-tech” NPD projects are increasing, along with the pressure to develop more new products. Rolling out new, technically challenging products at the right time has been a key success factor for more than a decade (Iansiti, 1993; Kok et al., 2003).

As product life cycles get shorter and technology changes at an ever-increasing pace, it becomes especially critical to have an effective and efficient NPD process (Birou & Fawcett, 1994) to improve company performance (Cooper & Kleinschmidt, 1995) and competitiveness (Browning & Eppinger, 2003). Companies that develop new products have started paying attention to the management of the NPD process, especially to integrating the activities of the various functional areas involved in NPD processes (Badir et al., 2005a; Bailetti et al., 1994). Many researchers have developed integration mechanisms, techniques, and tools (Dyer et al., 2001; Griffin & Hauser, 1996; Paashuis, 1998; Perona & Saccani, 2004) aimed at improving NPD project performance.

In today’s network world, advancement in NPD processes is being driven by different types of networks, joint ventures, alliances, outsourcing, and mergers. These network business trends have resulted in complex high-tech organisations and development projects that cross location, company, country and cultural boundaries. In such networks, each activity within the NPD process tends to be carried out by separate functions within or across the company boundaries. Once an activity is completed, the output is sent to the next function in the process so those responsible can contribute their specialised knowledge and skills to developing the product (Paashuis, 1998). In such projects, the NPD process often suffers from a lack of coordination and communication. Delays in and overspending on these projects are not uncommon (Badir et al., 2005b; Batt & Purchase, 2004; Nohria & Ghoshal, 1997). The key to success is no longer integrating the company's units and activities, but integrating the NPD process across a network of strategic partners (Chesbrough, 2003).

Managing the integration process elements in this increased organisational complexity requires a sophisticated organisational design to facilitate and support the coordination of activities and the flow of information across the network. I argue that no matter how well developed are the integration approaches and mechanisms, they are unlikely to succeed unless the surrounding organisational context is favourable. Indeed, inappropriate organisational design can be a barrier to integrating the NPD process across strategic partners (Sherman, 2004). Griffin and Hauser (1996) argued that the organisation in which the communication is to take place can be a barrier in itself. For example, the authors found that a functional organisation tends to communicate more within the functional departments, and less between the departments. Sherman (2004) stated that the coordination deficiency is due to characteristics of the organisational structure inhibiting coordination. He argued also that coordination problems are from the result of overburdening formalisation and excessive centralisation. However, these researches have focused mainly on the integration across the boundaries between functional areas within a firm. In this research, I extend this notion by investigating the impact of internal design of an organisation on the integration across the organisation's boundaries.

As networking between high-tech companies to develop new products has become an increasingly important strategy, a body of research pertaining to it has emerged (Roijakkers & Hagedoorn, 2006; Rothaermel & Deeds, 2004; Zineldin & Bredenlow, 2003). One related stream of research delves into the performance impact of alliances on the focal (central) firm (Gulati, 1998). In this line of inquiry, several scholars have studied the relationship between a firm's strategic alliances and its innovative performance or new product development (Shan et al., 1994; Kotabe & Swan, 1995; Deeds & Hill, 1996; Baum et al., 2000; Lerner et al., 2003).

While these studies have certainly advanced and enriched the NPD by establishing a link between a firm's strategic alliances and firm performance (Rothaermel and Deeds, 2004), studying the impact of a firm on the strategic alliance performance, specifically on the NPD project conducted with the strategic partners, has not yet been undertaken. The purpose of this research is to address this imbalance, and to direct attention toward the influence of a firm's internal organisation on the NPD process across strategic partners.

The inherent complexity of interfirm relationships and networks means that it is unrealistic to imagine that they can be wholly designed by any one party, still less that their evolution result solely from conscious, one-sided plans (Ford, 1997). Even though individual companies may be limited in their actions, each participant in a network has some influence on the network, which can be managed more or less efficiently. Ritter (1999) identified and described particular skills that allow companies to handle, use, and exploit single relationships and whole networks. Hakansson (1987) stated that there are substantial differences between companies in their ability to handle and influence networks. For instance, the network lead company (the central company in the network) is expected to have greater influence on the network's performance than the other partners. A common finding in social network studies is that central positions are often associated with power and influence (Brass & Burkhardt, 1992). Results consistent with this influence/centrality relationship have been reported in small laboratory work groups (Shaw, 1964), within organisations (Brass, 1985; Krackhardt 1990; Burkhardt & Brass, 1990), and across organisations (Galaskiewicz, 1979). In this research, I focus on the network lead company that has the central position in the network of strategic partners.

1.2 Research question

The research investigates the impact of organisational design of the network lead company on the NPD project's integration process elements with external partners, and the subsequent effects on performance. The "integration process elements" in this research are: "communication and coordination.[1]"

I focus on the R&D organisation in the network lead company. Within the R&D organisation, I adopt the project level of analysis and answer the main research question:
How can the network lead company design its R&D organisation to support the NPD project's communication and coordination activities with the project strategic partners and improve project performance?

The two expressions (integration process elements, and communication and coordination) will be used interchangeably throughout the research. However, due to the nature of the research

[1] See Chapter 3 for more information.

question, I only investigate the intensity[1] of communication and coordination between the NPD project team of the network lead company and the project strategic partners.

Based on contingent theory, I argue that different industries require different intensities of communication and coordination with the NPD project partners to develop new products efficiently. Different intensities are enabled by different organisational designs. The contingency theory states also that there is no one best way to organise, and that not all ways of organising are equally effective. Therefore, to efficiently develop the new product, it is crucial for the network lead company to identify, based on its contextual conditions and NPD project characteristics, the required intensity of communication and coordination that its NPD project team should have with the project strategic partners, and to find out the R&D organisational design that most likely would enable this required intensity. However, in order to answer the main research question, three important sub-questions must be dealt with first:

i. What intensity of integration process elements does the NPD project team require with the project strategic partners to efficiently develop the product, and what factors impact this intensity?
ii. What are the primary organisational attributes – to be used to design the R&D organisation – that have greatest influence on the integration process elements?
iii. How do these attributes impact the integration process elements?

1.3 Limitation of prior research

The researcher reviews the literature and published research findings about NPD management and organisation theory. The literature review covers the period from the early 1960s to 2005. However, most of the studies that developed integration mechanisms and approaches focused mainly on integrating the NPD processes and activities within a firm (Bailetti et al., 1994; Cooper, 1990; Griffin & Hauser, 1996; Millson & Wilemon, 2002; Moenaert & Souder, 1990; Paashuis, 1998). The few studies that investigated 'interorganisational' network integration focused on the relationships between organisations at a strategic level (Batt & Purchase, 2004; Zineldin & Bredenlow, 2003), while other studies focused on a headquarter-subsidiary relationship (Nohria & Ghoshal, 1997). The literature does not discuss how to achieve this integration across a network of high-tech strategic partners, especially at an NPD project

[1] See Chapter 4 for more information

level. On the other hand, although organisational attributes have been studied extensively in the literature on employee motivation, strategic decision processes, corporate governance, and organisational characteristics (Anthony, 1988; Menon et al., 2002; Miller, 1988), and although some evidence suggests that they influence organisation performance (Charan, 1991; Govindarajan, 1986), few studies have related them to integration of the NPD process within a firm (Griffin and Hauser, 1996), and even fewer to integration across firms (Bower, 2001).

This research attempts to extend the knowledge of NPD process integration across a network of high-tech strategic partners by proposing a contingency model, and by developing a condition of fit between contextual conditions that characterise the high-tech NPD project and organisational attributes. The model is constructed to support and facilitate the integration process elements – communication and coordination – with the project strategic partners, and thereby to improve the NPD project performance.

Along with to the lack of literature, some other reasons can be given as to why it is important to investigate the integration of the NPD process in a network of high-tech strategic partners:

i. *The complexity of the NPD process*: The NPD process is very complex and involves different sub-processes, activities, and tasks to be carried out by differently-focused entities and functional units within and/or across the company boarders. This complexity demands effective integration process elements between the strategic partners to build a collaborative network of organisations and to link and align the strategy, the NPD project goals, and the different development activities in order to improve the NPD project performance;

ii. *Difficulty in the flow of information in the network environment*: Because of the different focuses and missions of the connected companies, the differences in culture and the nature of the processes conducted by each company in the network, it becomes difficult to have an efficient communication between NPD project strategic partners;

iii. *Increasing demands for resources in the high-tech sectors*: In terms of money, labour, knowledge, experience, technology, channel of sales, and brands. There is a dire need among network partners to obtain the maximum benefits of their network's available resources. An organisational design that supports and facilitates resource sharing between the strategic partners is needed.

1.4 Research context

Since this research focuses on the integration of NPD project across network of high-tech strategic partners, it is important to define the following: network of strategic partners; network lead company; R&D organisation; and high-tech NPD projects.

1.4.1 Network of strategic partners

Strategic alliances and networking between previously independent organisations have recently escalated in importance (Cravens et al., 2000). Between 1991 and 2001, the average number of joint-venture deals announced each year increased dramatically, from 1000 to 7000 (Büchel, 2003). It has become increasingly rare to see innovation come out of isolation (Tomala and Sénéchal, 2004).

In most cases, high-tech organisations network with others because of their need for resources. Money is not the only resource, but also knowledge, experience, specialised skills, technology, access to particular kinds of markets, and relationships. The more an organisation needs partners' resources, the greater the need for better integration with them. This can be explained in the following steps (Badir et al, 2005b):

i. High competition and uncertainty in the high-tech sector forces high-tech organisations to innovate and develop new products to retain their market share and survive;
ii. Developing new products increases the need for resources;
iii. As the need for resources intensifies, organisations are more likely to partner with others in order to gain access to these resources; this leads to interdependence between the partners participating in the NPD projects;
iv. Heightened interdependence increases problems of communication and coordination, i.e., *integration*, between the strategic partners.

In addition to gaining access to others' resources, some organisations seek to share the risk associated with their high-tech NPD projects. Many researchers have described the potential benefits of strategic partnerships for NPD as increased innovation, reduced costs and time-to-market, improved quality of projects, and joint investment in R&D (Carr & Pearson, 1999; Cooper et al., 1998; Perona & Saccani, 2004; Rothaermel & Deeds, 2004).

In this research, a network of strategic partners is defined as a long-term formal relationship established between two or more independent parties (Cheng et al., 2004), specifically involved in developing a product or series of products (Littler et al., 1995). I only investigate the relationship between the network lead company and its strategic partners in which it has equity investments (minority holdings).

1.4.2 Network lead company

An interorganisational network may well be strategically led by a focal or 'hub firm' (Jarillo, 1988), which sets up the network and is responsible for the entire process of the NPD project – from idea to market – with input from its strategic partners. I refer to this firm as the *network lead company,* and it is the focus of this study. Figure 1-1 shows the participation of the strategic partners along the NPD process.

Jarillo (1988), who refers to this type of interfirm network a strategic network, sites the case of Benetton to illustrate this organisational form (i.e., the franchise-like Benetton outlets as well as Benetton's complex network of product manufacturers and service providers). The network lead company (the hub firm) represents the strategic apex of the network and holds ultimate responsibility for strategic direction and overall coordination of the NPD project activities (Sydow & Windeler, 1998). Effective communication and coordination with each strategic partner in the network are necessary if the network lead company is to carry out these NPD project direction-setting and integration tasks effectively (Aldrich, 1979). As Büchel (2003) states, poor partner relations lead to poor performance.

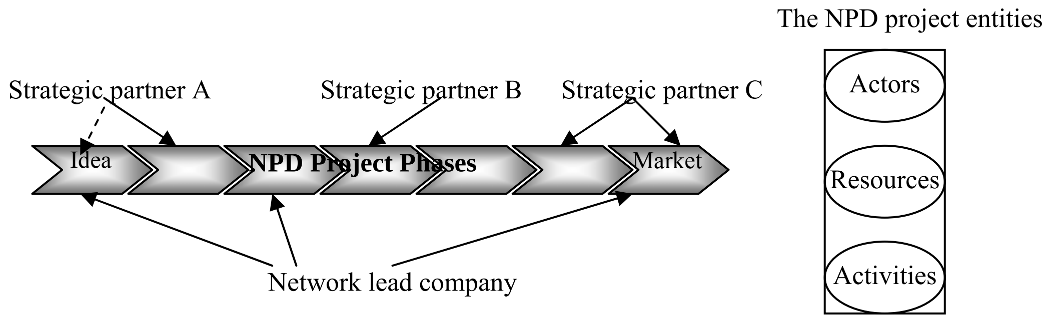

Figure 1-1: NPD project led by the network lead company with input from the strategic partners (*Source Badir et al, 2005b*)

It is important to note that in this research I do not investigate all relationships a network lead company may have. Rather, very similar relationships are taken together for further investigation (equity-based relationships).

1.4.3 R&D organisation in the network lead company

One of the most obvious sources of firm innovation is the firm's own research and development (R&D) efforts. Though the terms *research* and *development* are often lumped together, they actually represent different kinds of investment in innovation-related activities. However, it is sometimes difficult to determine when research ends and development begins. It is probably more realistic to view industrial R&D as a continuum with scientific knowledge and concepts at one end, and physical product at the other (Trott, 1998). It is possible to locate the various R&D activities along this continuum.

Research can refer to both basic research and applied research. In industry, the applied research has specific commercial objectives. Development refers to activities that apply knowledge to produce useful devices, materials, or processes. In consequence, the term *research and development* in this research refers to a range of activities that extend from early exploration of a domain to specific commercial implementations (Schilling, 2005).

1.4.4 NPD project

In high-technology organisations, new product development (NPD) is performed by groups and individuals from multiple functions, such as R&D, marketing, and manufacturing (Sheremata, 2000). The project includes all the activities needed to conceive, design, produce, and deliver a product to market, and is led by the R&D organisation of the network lead company. The NPD project is approached here as sequences of *activities* performed by the network's strategic partners (*actors*) that produce and/or consume *resources* (Hakansson & Johanson, 1992; Malone & Crowston, 1994; Ojasalo, 2004).

In this research I study three *new-to-firm-* development projects[1]. Drawing on organisational theory, the *newness* as familiarity concept is in reference to the relationship between the organisation and its environment (context in which an organisation is operated). It is argued that all organisations establish a domain, in which they are dependent on inputs from the

[1] See Chapter 4.

environment. Normann (1971) argues that new products may enlarge the domain of the organisation to such an extent that they cause the organisation to be confronted with an unfamiliar domain. Therefore, organisations are more confident in developing products in a well-known technical and market environment because of established channels of communication and existing structure. By contrast, developing products in different domains where the market or technological environment or both are unfamiliar may increase the uncertainties. Accordingly, many studies found that radical innovations pose greater challenges to firms and designers because of non-specific market opportunities (O'Connor, 1998; Rice et al., 1998), and uncertain technology (Veryzer, 1998) without relying on familiar research techniques (von Hippel, 1988). Moreover, the development of new products and new business based on radical innovations requires management practices that differ significantly from those required for incremental innovation (Rice et al., 1998). For example, after following eight cases of radical NPD projects, Veryzer (1998: 317) found that radical innovations involve a higher degree of technological uncertainty, longer development time, sequence of innovations, informal structure, and unconventional progression of the activities.

The three new-to-firm projects in this research are classified as *radical innovation* by the network lead companies. The network lead companies have no previous experience with the development process of these projects.

1.4.4.1 Characteristics of new-to-firm high-tech NPD projects

Featuring prominently in the literature on high-tech NPD projects are the underlying factors of high complexity and high uncertainty (Helms, 2002; Simon, 1996; Zander & Kogut, 1995).

Complexity

Simon (1996) defines complexity as the number of decomposed cells in a system. Tyre (1991) defines technical complexity as the number, novelty, and technological sophistication of new features and concepts in a technology. In this research and in line with Zander & Kogut (1995), I define complexity as the degree of multiple skills and competencies used to manufacture a product.

The importance of complexity as a variable in organisational analyses has been stressed by Zelditch & Hopkins (1961) who note, "Large size is not in itself a critical characteristic of organisations or projects. Rather what appears to be important is complexity, which is often indicated by size but quite distinct from it." Studies by Bensaou & Venkatraman (1995), Daft & Macintosh (1981), and Van de Ven & Ferry (1980) show that communication, information processing, and coordination increase or decrease depending on the complexity of projects. In other words, the need to integrate the NPD process increases with the increasing complexity of an NPD project.

Uncertainty

Trott (1998) states that managing uncertainty is a central aspect of managing the innovation process. According to Daft & Macintosh (1981), "uncertainty arises from difficulty in seeing into the task and in analysing it in terms of alternative courses of action, cost, benefits and outcomes."

Many researchers have linked uncertainty to organisational arrangement. Older research (Burns & Stalker, 1961) and more recent research (Tatikonda & Rosenthal,2000) argue that when uncertainty increases, an organisation should move from 'mechanistic' approaches to more 'organic' approaches. In this regard I can also refer to Berden et al. (2000) who write that decentralised information feedback and feed-forward approaches are recommended in unstable, uncertain processes. However, some other researchers are not convinced that only organic approaches should be used when dealing with uncertainty in high-tech NPD projects. A balance between rigidity and flexibility seems necessary (Ettlie et al., 1984). However, Egelhoff (1988) states that uncertainty at the NPD project level means that more information processing and coordination are required to maintain integration between the project functions.

1.5 Research methodology

There is too little detailed knowledge available on the impact of the network lead company's organisational design on the integration across a network of strategic partners. Indeed, the existing knowledge base is fairly poor, and the available literature provides no conceptual framework or notable hypotheses. Such a knowledge base does not lend itself to the development of good theoretical statements, and any new empirical study is likely to be characterised as an exploratory study.

This research tries to increase this knowledge by exploring, describing, and explaining the complex relationships between selected organisational attributes and the integration process elements (communication and coordination), and the impact of this relationship on project performance. The research adopts an exploratory study approach, using case studies.

Case study research is an appropriate method of data collection for such a complex subject. A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, where the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used (Yin, 1989).

An analytical strategy should guide data collection (Yin, 2003). In this research, I developed a theory-based preliminary model to guide the design and data collection for case studies. Reliance on theoretical concepts remains one of the most important strategies for completing successful case studies. Such theoretical concepts can be useful in conducting exploratory, descriptive, or explanatory case studies (Yin, 2003). In developing the preliminary model, I lean primarily on two streams of research: (1) the NPD management; and (2) organisation theory.

I then validate, support, and enrich the preliminary model by the results of three “new to firm” product development projects from different industries: electronics, biotechnology, and mechanics. Each project is led by a high-tech firm. These three firms are situated in Switzerland and occupy the lead position in the network. In addition, in order to bolster the sense of representativeness of the cases, I conduct interviews with eleven other professionals working in other high-tech companies, and record their opinions about the model. The gaol is to gather the extent to which the model reflects the reality, and if it is applicable to other industries as well.

1.6 Thesis overview

The remainder of this thesis is organised as follows. Chapter 2 presents previous research on the NPD management, organisational theory, and network literature. In Chapter 3, I developed the theory-based preliminary model of the organisational attributes and its impact on the integration process elements. Chapter 4 sets the empirical methodology, and details the research methodology, operationalisation, and analysis. In Chapter 5, I describe at length the three case studies. Chapter 6 presents the findings and results of the three case studies. In chapter 7, the results of the three case studies are discussed and analysed. Finally, in Chapter

8 I discuss the conclusions and management implications, the limitations of the research, and offer suggestions for further research. Figure 1-2 presents an overview of research design.

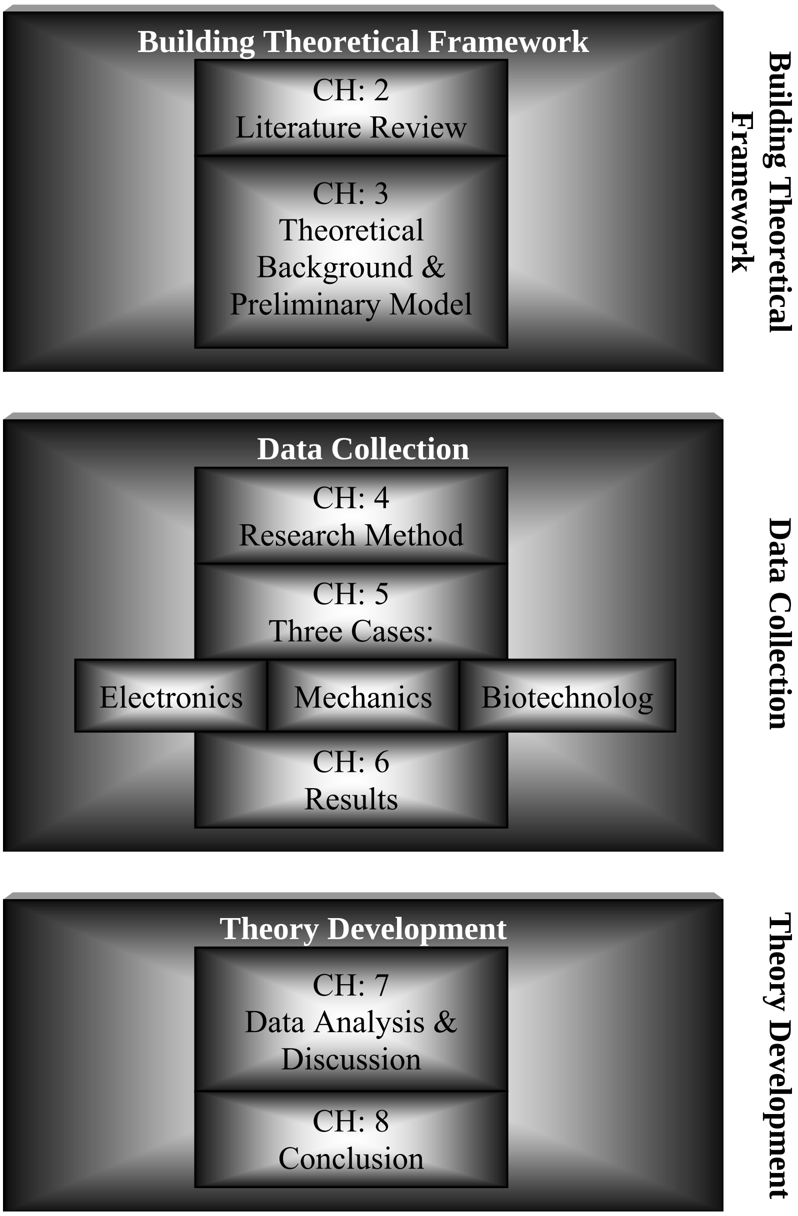

Figure 1-2: Overview of research design

2 Literature review

2.1 Introduction

This chapter presents the background to, and describes the key features of, three streams of research: innovation and new product development (NPD) management, organisation theory literature, and network and strategic alliances literature (Figure 2-1).

Figure 2-1: The targeted literature in this research

2.2 Innovation

Schumpeter (1934: 73) provides a general definition of innovation: “the commercial or industrial application of something new – a new product, process or method of production; a new market or source of supply; a new form of commercial, business or financial organisation.”

A review of the literature reveals that the OECD (1991) study on technological innovations best captures the essence of innovations from an overall perspective: ‘Innovation’ is an iterative process initiated by the perception of a new market and/or new service opportunity for a technology-based invention which leads to development, production, and marketing tasks striving for the commercial success of the invention.

This definition addresses two important distinctions: i) The ‘innovation’ process comprises the technological development of an invention *combined* with the market introduction of that invention to end-users through adoption and diffusion, and ii) The innovation process is *iterative* in nature and, thus, automatically includes the first introduction of a new innovation and the reintroduction of an improved innovation. This iterative process implies varying degrees of innovativeness, thereby necessitating a typology to describe different types of innovations. As pointed out by some reviewers, the OECD definition also references 'technology-based inventions.' Technological innovations are those innovations that embody inventions from the industrial arts, engineering, applied sciences, and pure sciences. Examples include innovations from the electronics, aerospace, pharmaceuticals, and information systems industries. Figure 2-2, shows the interactive process of the innovation.

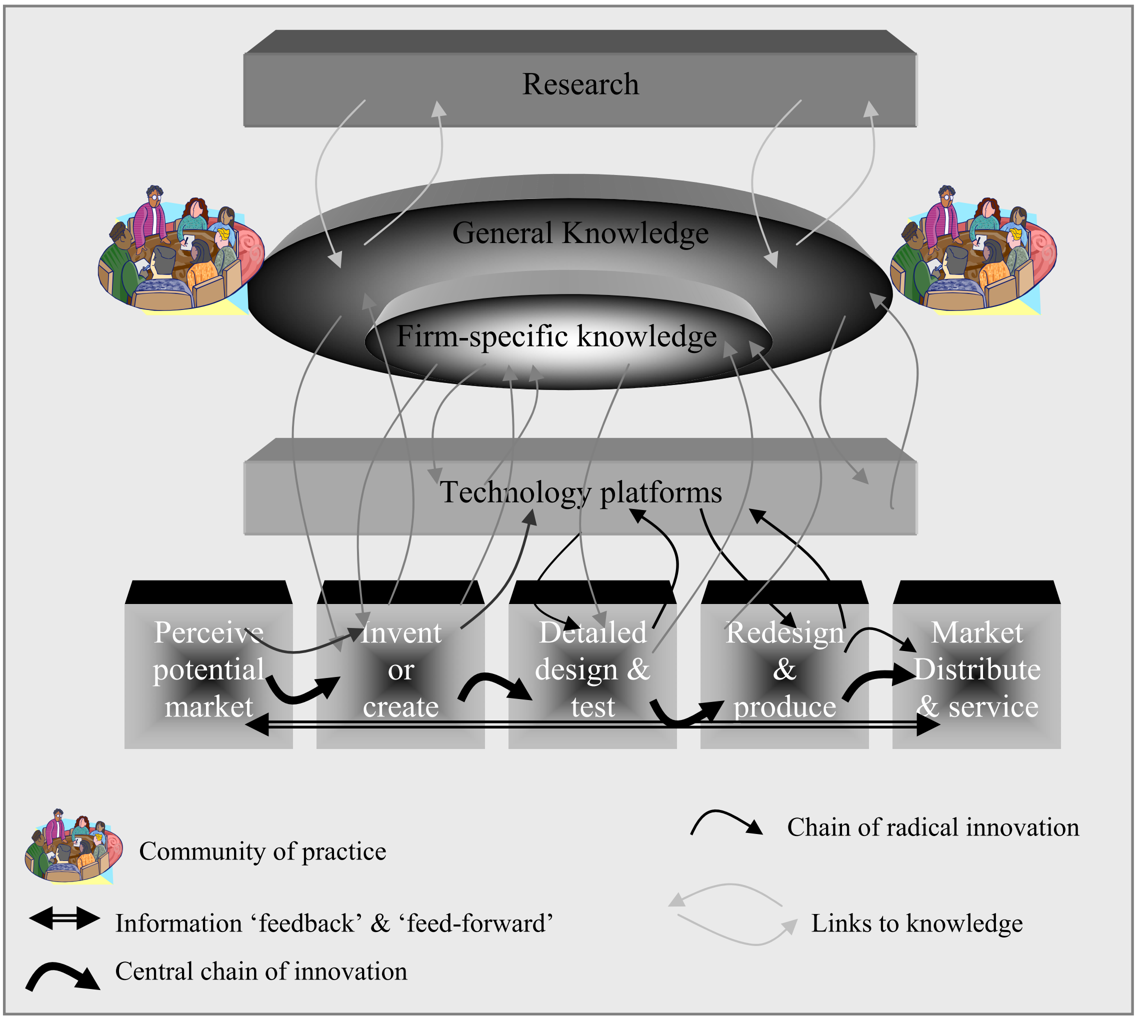

Figure 2-2: The process model of innovation
(Adapted from: Rosenbloom & Spencer, 1996)

2.2.1 The concept of system of innovation

A strong idea in the system of innovation approaches is that the model of isolated profit-maximising firm is an inappropriate tool for interpreting certain important aspects of the processes for the generation and diffusion of innovations (Nelson, 1993). Edquist (1997:14) defined a system of innovation as “all important economic, social, political, organisational, and other factors that influence, the development, diffusion, and use of innovations”.

Lindegaard (1997) presents the systems of innovation approach in an operational “propeller” model (Figure 2-3). The propeller model of the interactive innovation network domains of the innovation system points out the main actors and learning networks in the system as regards a specific organisation or industry. The external sources of knowledge acquisition for industries or organisations are: a) suppliers and related industries; b) R&D community; c) customers and competitors or relevant market; d) regulatory authorities; e) public sphere movements. The ideal learning network domains are: a) science-based user-producer of R&D systems and suppliers; b) market-based user-producer of suppliers and customers/competitors; c) dynamic regulation of regulatory authorities and R&D system; d) credibility, public acceptance of citizen groups and market customers/competitors; e) legitimacy among citizen groups and authorities, governability.

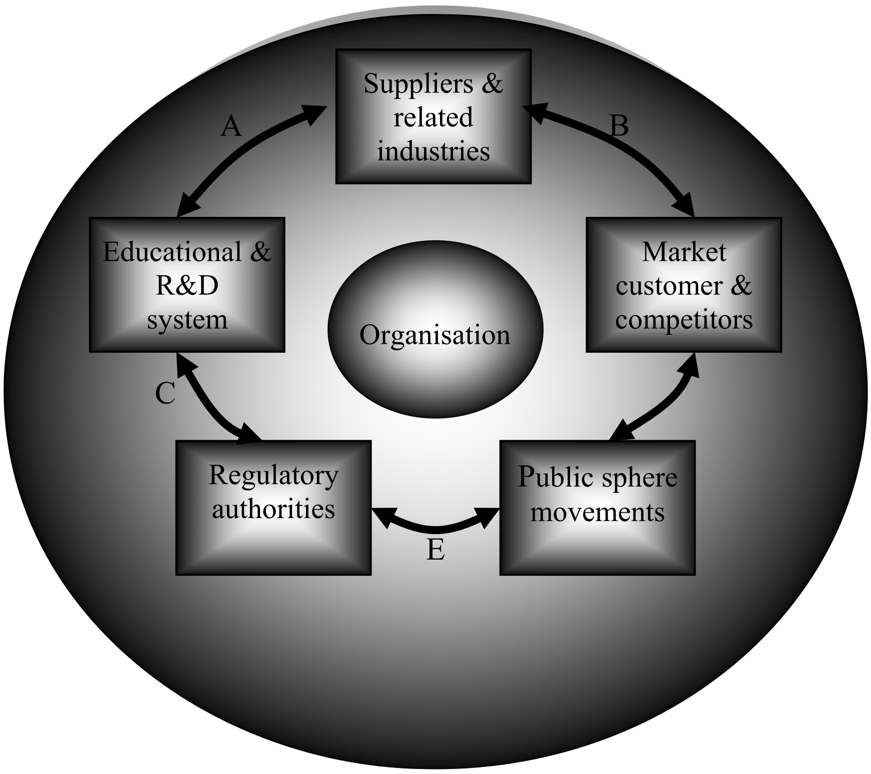

Figure 2-3: Propeller model of interactive innovation network domains of the system of innovation
(Adapted from: Lindegaard, 1997)

2.2.2 Product innovativeness

According to Johannessen *et al*. (2001) every definition of innovation is related to the concept of newness that may be investigated according to three dimensions: What is new? How new? New to whom? 'Innovativeness' is most frequently used as a measure of the degree of 'newness' of an innovation (Garcia & Calantone, 2002). 'Highly innovative' products are seen as having a high degree of newness and 'low innovative' products sit at the opposite extreme of the continuum. However, little continuity exists in the new product literature regarding from *whose* perspective this degree of newness is viewed and *what* is new. Although the majority of research takes a firm's perspective toward newness, some looks at new to the world (Song & Montoya-Weiss, 1998), new to the adopting unit (Ettlie & Rubenstein, 1987), new to the industry (O'Connor, 1998), new to the market (Kleinschmidt & Cooper, 1991; Meyers & Tucker, 1989), and new to the consumer (Atuahene-Gima, 1995), (see Table 2-1).

In the literature, technological innovations are usually classified as incremental or radical, according to not very clearly defined criteria. In reality, innovations are not all white or all black, but also come in various shades of grey. Abetti & Stuart (1988) has developed a method for measuring the uniqueness of a technological innovation according to a 5-level scale, as show on Table 2-2. *In this research, I study three technology-intensive (high-tech), new-to-firm projects, all of which are engaged in the development of radical innovative products. Each project is conducted in collaboration with external partners.*

Table 2-1: Product newness
(Adapted partially from: Garcia & Calantone, 2002)

New to whom?	Sources
- New to the world	Kleinschmidt & Cooper (1991); Lee & Na (1994); Atuahene-Gima (1995).
- New to the industry	Maidique & Zirger (1984); Green, Gavin, & Aiman-Smith (1995); Schmidt & Calantone (1998).
- New to scientific community	Cooper & de Brentani (1991); Green et al. (1995).
- New to the market(place)	Cooper (1979); Maidique & Zirger (1984); Yoon & Lilien (1985); Ali, Krapfel, & LaBahn (1995); Schmidt & Calantone (1998).
- New to the firm	Cooper (1979); More (1982); Cooper & de Brentani (1991); Kleinschmidt & Cooper (1991); O'Connor (1998); Goldenberg, Lehman, & Mazursky (1999).
- New to the customer	Ali, Krapfel, & LaBahn (1995); Olson, Walker & Ruekert (1995).

Table 2-2: Innovation uniqueness
(Adapted from: Abetti & Stuart, 1988)

Level	Description	Type of innovation
1	Unique original product or system, which will obsolete existing ones, based on proprietary technology beyond the state-of-the-art, highly specialised and customised, major R&D	Highly radical
2	New product or system, with original state-of-the-art proprietary technology, that will significantly expand the capabilities of existing ones, specialised product with many adaptations, significant R&D	Radical
3	New product with proprietary technology, but may be duplicated by others, mix of standard and special features, average R&D	Intermediate
4	Significant extension of product characteristics with original adaptations of available technology, product with standard variations, limited patent protection, minor R&D	Significant incremental
5	Incremental improvement over existing products, application of current technology, standardised product, no patent protection, no R&D	Minor incremental

2.3 New product development (NPD)

The Product Development and Management Association PDMA Hand Book (2002) defines product development (PD) as the overall process of strategy, organization, concepts generation, product and marketing plan creation and evaluation, and commercialisation of a new product. The MIT Centre for Innovation in Product Development defines PD as the process by which a product comes to market. Others (APQC, 1998; Wheelwright & Clark, 1992) define PD as the flow of activities and decisions from identification of market need to production and use of product. From a management perspective, PD process is a disciplined and defined set of tasks, steps, and phases that describe the normal means by which a company repetitively converts embryonic ideas into scalable product (PDMA, 2002). The main objective of any PD process is the design, development, and manufacture of the right product and supply it to the right customer at the right time.

2.3.1 NPD process integration

Lawrence and Lorsch (1986) define integration as the process of achieving unity of effort among the various subsystems in the accomplishment of the organisation's task. Hitt *et al*

(1993) state that integration facilitates reciprocal information flow among functions responsible for the development, design, and implementation of the innovations. The PDMA (2002) defines integrated product development as a philosophy that systematically employs an integrated team effort from multiple functional disciplines to develop, effectively and efficiently, new products that satisfy customer needs.

According to Thompson (1967), integration may be achieved through standardization, by plans or by mutual adjustment. The author concludes that standardization is most suitable when the interdependence between organisational units is of a pooled nature, coordination by plans is a function of sequential interdependency, and mutual adjustment is called for when the interdependency is reciprocal. Moreover, the burden of the mechanism on decisions, communication, and resources increases from standardisation plans to mutual adjustment.

Galbraith (1973) suggests seven lateral processes to integrate the work of different functional specialties: direct contact, liaison roles, task force, teams, integrating role, managerial linking role, and matrix form. Direct contact between managers shifts the decision making to the lower level of the hierarchy, thereby improving the quality of the decision making. Liaison roles are designed to enhance the lateral communication between two interdependent departments. Task forces are used when the problem involves several interdependent departments. Teams are used when group problem solving is to be used on a more permanent basis, typically around frequently occurring problems. The integrator is a “little general manager” with responsibility for a particular decision process. The integrators do not do the work, but rather coordinate the decision making process. In the managerial linking role the authority of a formal position is added to the expert power of the integrating role. The matrix organisation creates a formal dual reporting relationship to guarantee the efficient use of resources and to maintain the level of technical specialisation.

Van de Ven *et al*. (1976) divide the coordination modes within organisations into two general types, by programming or by feedback. The coordination by programming is further divided into a personal and a group mode.

More recent research has studied the cross-functional integration mechanisms in NPD. New product development is inherently paradoxical in nature (Donnellon, 1993). It requires both specialisation and integration. Clark and Fuijimoto (1991) divide NPD into two main problems: (i) problem differentiation – how to get a product's parts and subsystems designed, built, and tested so that each element achieves a high level of functionality; and (ii) problem integration – how to achieve product integrity.

From an organisational standpoint, the former requires functional specialisation by component, subsystem, or functional task or any combination of these. On the other hand, the latter requires an integrated development process, which can be further divided into internal integrity – integration within the project team; and external integrity – integration with the customer (Clark & Fuijimoto, 1991). In this research, I focus on the integration with the external partners, which, for purposes of this research are principally the product's components and technology suppliers. According to Clark and Fuijimoto (1991), if the product's performance is heavily dependent on the components' ability to work together, the integration aspect should be emphasized.

Although NPD process integration has been an important formal concern of companies for well over 40 years and continues to be, there is still much to understand about the process as companies continue to have spectacular NP failures. Only one NPD project in four becomes a winner (Cooper 1990). However, while much has been written about the theory and practice of product development within firms (Trygg, 1991; Adler, 1995; Nihtilä, 1996), little effort has been focused on the development process in networks of strategic partners, and much less on high-tech NPD processes across networks of strategic partners. NPD projects conducted by networks of strategic partners require the efforts and resources of multiple partners. How to integrate these different partners' efforts and resources is the question this research tries to answer. Indeed, most of the previous work on NDP projects within a firm has assumed a certain level of control exercised by the firm over its units and functions that needed to be integrated (e.g. R&D/marketing). The NPD theory, which is developed for application within a firm, can barely be transferred to a network of high-tech strategic partners, mainly because of the complex relationship between independent organisations in the network, and also due to specific characteristics such as high complexity and uncertainty of high-tech networks. This research investigates the integration of NPD processes conducted by strategic partners, each representing an independent organisation.

2.3.2 Characteristics and measurement of successful product development

Product development is successful if the products not only fulfil the needs and the requirements of customers, but also generate shareholder value (i.e., profits). In other words, the two main characteristics of a product development project are historically its quality and profitability, where "quality" represents how well the product satisfies the customer needs, and "profitability" represents how much profit it can generate with restraints of budget and schedule. The instruments developed to measure the performance of a product development, therefore, were tailored to meet those two characteristics. The widely-used measurements are drawn from the following three perspectives (Griffin & page, 1993):

i. Customer or consumer-based: customer loyalty and market share
ii. Financial-based: Cost & Expense. (Can this organization make money?)
iii. Technical & process-based: (Time-to-Market) and quality.

It is important to decide at the project's inception what the success criteria will be. To measure the success of the project and consequently to be able to manage it, it is imperative to put measurement systems in place. Apart from recognising success, the measurement systems also address the question, "where are we now?' That is, they provide a status for the project. Additionally, they provide a way of motivating people and making their contributions apparent.

For example, PRTM (McGrath, 1995) measures the success of product development in terms of the ability to cut time-to-market in half and competitive advantage; Cooper *et al.* (1995) suggest 10 performance measurements of a company's new product development: success rate, percentage of sales, profitability relative to spending, technical success rating, sale impact, profit impact, success in meeting sales objectives, success in meeting profit objectives, profitability relative to competitors, and overall success. A list of the fifteen most common measures, as identified by Driva *et al.* (2000), is shown in Table 2-3.

The above measurements, however, are not always in place, mainly because they are time consuming and fail to capture all factors (Mahajan and Wind, 1992). They provide, however, tangible information about the product development's status, and thus they make the decision making less risky and more rational. *In this research, I use product-related measures (Griffin & Page, 1993) to assess the project performance: cost, schedule, and quality (technical* *performance). My assumption is that these criteria are common and used in almost all companies, so that it will be possible to compare the performance of the projects.*

Table 2-3: Most common measures used by companies

No.	NPD process measurements
1	Total cost of project
2	On-time delivery of development project
3	Actual project cost compared to budget
4	Actual vs. target time for project completion
5	Lead time to market
6	Field trials prior to production
7	Projected profitability analysis
8	Product failure rates
9	Supplier lead time
10	Reasons for failures in the market
11	Product prototype based safety tests
12	R&D budget as % of turnover
13	Time spent on each stage of product development
14	Product met quality guidelines
15	Actual to predicted profit on products

2.4 Organising for Innovation

There are variables and combinations that have been studied for their influence on an organisation, including size, age, tasks performed, environment, and company strategy (Child, 1980; Greiner, 1972). The extensive debate on organisational structure began to resolve itself into a 'contingencies' model in the 1970s. In essence, this view argues that there is no single 'best' structure, but that successful organisations tend to be those that develop the most suitable 'fit' between structure and operating contingencies (Tidd et al., 1997). For example, it makes sense to structure an operation like McDonald's in a mechanistic and highly controlled form, in order to be able to replicate this model across the world, and to be able to deliver similar standards of product and service. But efforts to develop a new computer operating system or genetically engineer a new drug would not flourish in such a structure. The key challenge here for managing innovation remains one of fit – of getting the most appropriate structural form for the particular circumstances.

2.4.1 Impact of organisation size and age on organisation design

The question of how the organisational setting relates to the ability and propensity to innovate has been widely examined by a large body of empirical literature (Cohen, 1995) inspired by two contrasting statements of Schumpeter (1934, 1942). The first one states that entrepreneurship is a mechanism to create changes in the system through innovation, and that entrepreneurs are creative destruction agents (Schumpeter, 1939). The second one states that large firms will be proportionately more innovative than small firms (Schumpeter, 1942). The existence of such a large body of literature does not seem to guarantee a clear interpretation of the findings due to the difficulties of measuring innovative activity (Cohen, 1995).

The age of the firm is perceived in the organisation theory literature as an indication of external legitimacy, of staying power, or of the pervasiveness of internal routines (e.g. Stinchcombe, 1965). The size of the firm has often been associated with the extent of the firm's resources, with the existence of internal procedures such as formalisation, controls, or decision-making processes, with market presence and related network effects, and with competitive strength (Aldrich & Auster, 1986). The age and size of the organisation, because of their relevance to both external relationships and internal arrangements, have direct implications for the process of innovation. The age and size of the organisation are often treated as overlapping dimensions. Young organisations are usually small, although the contrary is not true. While established organisations are not large by definition, the opposite is valid.

Conventional wisdom suggests that young and small firms have a greater advantage in innovation (Acs & Audretsch, 1990). In general, those firms possess capabilities like niche-filling and flexibility, seeking out protected market niches that are too small for larger organisations (Chen & Hambrick, 1995). Moreover, these organisations are also seen as being quicker than established organisations due to structural simplicity, streamlined operations, absence of structural inertia, faster decision-making process, and targeted innovation (Dean, Brown, & Bamford, 1998). These arguments seem to be supported by many recent studies, which tend to find that small firms have introduced, proportionately, more innovations than their share of employment. This finding has frequently been interpreted as showing that small firms are more innovative than large firms, or that they are more efficient innovators, achieving greater outputs per unit of R&D input (Acs & Audretsch, 1991; Cohen, 1995).

However, after using a historical analysis of a relatively large number of radical innovations, Chandy and Tellis (2000) found that the established and large organisations introduced a majority of the radical product innovations in the last 50 years.

The literature sources referenced above argue that the size and age of the organisation have an impact on the organisation's design, and consequently its innovation capability. In order to neutralise the impact of age and size on the output of this empirical research, and to reduce extraneous variation due to either, the three case studies that have been undertaken are all medium-sized, well established (more than 25 years old) companies.

2.4.2 Impact of nature of tasks and activities on organisation design

Much of the literature recognises that organisational structures are influenced by the nature of the tasks to be performed within the organisation. In essence, the less programmed and more uncertain the tasks, the greater the need for flexibility around the structuring of relationships (Thompson, 1967). Examples include production, order processing, purchasing, etc. – all of which are characterised by decision-making that is subject to little variation. Indeed in some cases these decisions can be automated through employing particular decision rules embodied in computer systems, etc. Others, however, require judgement and insight, and vary considerably from day to day – and these include those decisions associated with innovation. Several writers have noted this difference between what have been termed programmed and non-programmed decisions, and have argued that the greater the level of non-programmed decision-making, the more the organisation needs a loose and flexible structure (Perrow, 1967).

Generally, in high-tech sectors (e.g. IT and biotechnology), the tasks are less programmed, and highly complex and uncertain. *The question that arises here is: Based on the argument above, is it true that all high-tech companies are flexible organisations? Moreover, in addition to task complexity and uncertainty, are there other characteristics that may influence the organisation's design? This research tries to answer those two questions by investigating the organisational design of three high-tech companies from different industries. The development tasks in these organisations are characterised by high complexity and uncertainty in order to reduce extraneous variation due to these two characteristics.*

2.4.3 Impact of environment on organisation design

Burns and Stalker (1961) outlined the characteristics of what they termed ‘organic’ and ‘mechanistic’ organisations. The former are essentially environments suited to conditions of rapid change, while the latter are more suited to stable conditions. Although these represent opposite poles on an ideal spectrum, they do provide useful design guidelines about organisations for effective innovation. More recent work by Kanter (1984) has come up with a largely similar prescription, based on her studies of effective innovators such as Hewlett Packard. The relevance of Burns and Stalker’s model can be seen in an increasing number of cases where organisations have restructured to become less mechanistic. For example, in order to meet its dynamic environment needs, General Electric underwent a painful but ultimately successful transformation, moving away from a rigid and mechanistic structure to a looser and decentralised form (Moody, 1995).

Related to this work has been another strand that looks at the relationship between different environments and organisational form. Once again, the evidence suggests that the higher the uncertainty and complexity in the environment, the greater the need for flexible structures and processes to deal with it (Miles and Snow, 1978; Lawrence and Dyer, 1983). This partly explains why some fast-growing sectors, for example electronics, are often associated with more organic organisational forms, whereas mature industries often involve more mechanistic structures.

One important study in this connection was that originally carried out by Lawrence and Lorsch (1986), looking at product innovation. Their work showed that innovation success in mature industries like food and growing sectors like plastics depended on having structures which were sufficiently differentiated (in terms of internal specialist groups) to meet the needs of a diverse market-place. But success also depended on having the ability to link these specialist groups together effectively so as to respond quickly to market signals. Lawrence and Lorsch reviewed several variants on co-ordination mechanisms, some more effective than others and some less so. Better coordination was associated with more flexible structures capable of rapid response (Tidd et al., 1997).

In this research, I study three organisations acting in similar environments. Generally speaking, high-tech industries are characterised by rapid change, dynamism, and uncertainty. This minimises the variation due to the external environment.

2.4.4 Organisation and NPD performance

Studying determinants at the organisational level is a more recent phenomenon than doing so at the project level. For example, Cooper & Kleinschmidt, who are among the most active scholars in studying NPD success and failure, did not investigate the relationship between the organisation and NPD until their later work (Ernst, 2002). Accordingly, more research is needed that explores and explains the organisational characteristics that influence NPD performance (Brown & Eisenhardt, 1995).

At the organisational level, the unit of analysis includes various aspects of the organisation and several mechanisms within the organisation that influence product performance. Here, product performance is defined variously in different research schools. The performance can be financial in nature as well as related to the process and the effectiveness of the product concept (Brown & Eisenhardt, 1995). The determinants used at the organisational level include aspects concerning the way firms organise their activities for new products, as well as the strategy and culture of the firm (Cooper & Kleinschmidt, 1995; Ernst, 2002). Table 2-4 presents the main organisational factors influencing the performance, based on Cooper and Kleinschmidt (1995), Brown and Eisenhardt (1995), and Ernst (2002).

As shown in this section, there are many studies of internal organisational designs to improve process of innovation, project performance, etc., all of which are aiming at improving 'within a firm' activities. However, some projects need the efforts and resources of multiple partners. The questions that arise here are the following: How does one integrate the activities of these joint NPD projects? Which organisational design would most likely support and facilitate the integration of these types of projects? The literature provides no significant insight into the impact of organisational design on the NPD process across networks of strategic partners. In this research, I extend the work of Cooper and Kleinschmidt (1995) and Ernst (2002) and investigate the relationship between a company's internal organisational design and the integration process elements with the NPD project high-tech strategic partners, and the subsequent impact on project performance.

Table 2-4: Organisation aspects influencing the product performance
(Adapted from Berchicci, 2005)

Organisation aspects	Success factors for new products	Sources
How the firm organises its activities with regard to new products	Cross-functional team	Cooper & Kleinschmidt; 1995, Griffin 1997; Dougherty, 1992.
	A strong and responsible project leader	Cooper & Kleinschmidt; 1995
	NPD team and team leader commitment	Thamhain, 1990; Dougherty, 1992.
	Management involvement and commitment	Cooper & Kleinschmidt; 1995
	Intensive communication	Cooper & Kleinschmidt; 1995; Dougherty, 1992.
Culture	Allow the emergence of entrepreneurs and risk taking attitude	Cooper & Kleinschmidt; 1995
	Product champions	Barczak, 1995
Strategy	Clear goal and strategic focus in NPD programme	Thamhain, 1990; Cooper & Kleinschmidt; 1995
	Market information and NPD programme	Balbontin, 1999, Cooper & Kleinschmidt; 1995
	User involvement	Hipple, 1977

2.5 Alliances and networks

Over the last decade, the innovation studies and organisational and strategy management literature have increasingly focused their attention on networks, coalitions, and other collaboration forms (Gulati, 1999; Ahuja, 2000) to explore organisation performance and the ability to innovate through relationships with other organisations. Coombs *et al.* (1996) stated that two main approaches deal with networks in the innovation process: the sociological approach and the economic approach.

2.5.1 Social networks

In the recent years there has been a growing interest in understating the influence of the social context in which firms are embedded on their behaviour and performance (Gulati, 1998). The social context in which firms are embedded includes a whole array of elements that can be classified broadly as structural, cognitive, institutional, and cultural (Zukin & DiMaggio, 1990). This approach encompasses a large number of interdisciplinary studies focusing on the interactions between actors within and between organisations. The emphasis is on the exchange of tacit knowledge, on the nature of the linkages, and the process of their creation and development between individual actors, users, suppliers, regulatory authorities, and potentially competing firms (Callon et al., 1992; Coombs et al., 1996; Herbert, 1984; Pfeffer & Nowak, 1976). Additionally, the establishment and maintenance of linkages are essential for the success of innovation; weak linkages are associated with failure. Typically, these studies emphasised such phenomena as power in interfirm networks (Cook, 1977), and the collusive functions of interlocking boards of directors (Mizruchi & Schwartz, 1987).

Social networks may provide informational benefits through relational embeddedness (Granovetter, 1992). Relational embeddedness typically suggests that across who are strongly tied to each other are likely to develop a shared understanding of the utility of certain behaviour as a result of discussing opinions in strong, socialising relations, which in turn influence their actions (Coleman et al., 1966). Cohesively tied actors are likely to emulate each others' behaviour. Cohesion can also be viewed as the capacity for social ties to carry information that diminishes uncertainty and promotes trust between actors (Granovetter, 1973; Burt & Knez, 1995). Thus, cohesive ties can become a unique source of information about the partner's capabilities and reliability.

2.5.2 Economic approach

The economic approach focuses on the organisation itself and the role of the firm as a central institution through which the innovation is commercialised (Coombs et al., 1996). The *formal network* is therefore the main concern: the formal collaborative agreement involving legal contracts between organisations. Economists have traditionally been interested in the potential and real anti-competitive implications of join ventures and other forms of collaboration between and among firms. This literature views alliances as a means for firms to gain market power and extract monopoly rents (Boyle, 1968; Berg and Friedman, 1980). From the economic perspective, two different theoretical approaches are usually discussed (Berchicci, 2005).

The first one, known as *Transaction Cost Economics* theory (TCE), is concerned with the nature of the transaction and the cost incurred in managing the transaction. TCE arguments suggest that alliances are preferable and more efficient than market or hierarchy co-operation if they minimise the firm's cost in the transaction (Ireland et al., 2002).

The second is the *Resource-Based View* (RBV) theory. The RBV theory suggests that the establishment of alliances derives from the resource needs of the firm. Managing these resources can provide a competitive advantage over rivals. Thus, firms form alliances to obtain access to needed assets (Ireland et al., 2002; Teece, 1996), learn new skills (Baumann, et al., 2000), manage the dependence upon other firms (Pfeffer & Salancik, 1978), or maintain parity with competitors (Garcia-Pont & Nohria, 2002).

This research aims at supporting the social network theory and the RBV theory. On the one hand, the social network theory highlighted the importance of cohesively tied actors to circulate information and knowledge. On the other hand, the RBV theory emphasised the importance of sharing and managing resources. In this research, I investigate the impact of the network lead company's organisational design on the network actors' communication and resource coordination.

Modern research on strategic alliances may be dated from the publication of an influential work (Contractor & Lorange, 1988) that surveyed the emerging field of international business cooperative strategies. Contractor and Lorange portrayed the strategic alliance literature as fragmented, with many disciplines laying claim to the field. No overarching framework has yet emerged. Over a decade later this is still a common notion (Osborn & Hagedoorn, 1997). Alliance research is conducted by economists, organisation theorists, sociologists, strategic management, marketing, operations management, and international business scholars, and employs the gamut of methodologies and theoretical frameworks indigenous to those fields. Koza and Lewin (1998) classify the recent strategic alliance research under six categories, Table 2-5.

However, as shown above, most studies that investigated alliances and networks focus on the relationships between organisations at a strategic level, such as decision to enter an alliance, choice of an appropriate partner, the choice of structure for the alliance, and the dynamic evolution of the alliances (Gulati, 1998). The literature has also investigated performance consequences, both in terms of the performance of the alliance relationship itself (Harrigan, 1986; Parkhe, 1993) and the performance of the firms entering alliances (Hagedoorn & Schakenraad, 1994; Ahuja, 1996). While such studies have advanced our understanding of strategic issues in alliances, and network performance, an important extension would be to *focus on the impact of a firm on the network performance. Specifically, the impact of the organisation design of the network lead company on the NPD process integration with strategic partners. This research aims at filling this gap, and extends the knowledge of interorganisational networks by developing a model to support the integration process elements between project strategic partners.*

Table 2-5: Strategic alliance research categories

Taxonomy of strategic alliance research	Sources
Inter-organisational relationships and network	Astley, 1984; Astley and Fombrun, 1983; Bresser and Harl, 1986; Burt, 1992; Koza and Lewin, 1998. Gulati, 1995. Rond and Bouchikhi, 2004; Batt and Purchase, 2004; Zineldin and Bredenlow, 2003.
The choices of alliances	Buckley and Casson, 1988; Hennart, 1988; Hennart and Reddy, 1997; Badir et al., 2005a; Koza and Lewin, 1998.
The antecedents, structure, and functions of alliances,	Beamish, 1985; Contractor and Lorange, 1988; Reuer and Miller, 1997; Sydow and Windeler, 1998; Reuer et al., 2002; Soh and Roberts, 2005.
Incentive issues (such as contracting, opportunism, and trust)	Gulati, 1995; parkhe, 1993; Rond and Bouchikhi, 2004.
Alliance success, failure, and stability	Doz, 1996; Parkhe, 1993; Shenkar and Yan, 2002
Guidelines for the better management of alliances	Doz, 1996; Harrigan, 1986; Killing, 1993, Bensaou and Venkatraman, 1995,

2.5.3 Interfirm R&D Partnership

R&D partnerships are part of a relatively large and diverse group of interfirm relationships found between standard market transactions of unrelated companies and integration by means of mergers and acquisitions. When interfirm relationships began to attract attention in the economics and the business and management literature, a number of taxonomies of different modes of interfirm relationships were introduced that have gradually become well-integrated in the literature, to the extent that it now seems sufficient to only outline the main forms of interfirm relationships. See Auster (1987), Chesnais (1988), Contractor and Lorange (1988), Dussauge and Garetti (1999), Hagedoorn (1990 & 1993), Narula (1999), Nooteboom (1999), Osborn and Baughn (1990), Yoshino and Rangan (1995) for some of these taxonomies. As this section concentrates on R&D partnerships, I will briefly focus on those partnerships that one can expect to have an impact on R&D, innovation, and technological development.

Figure 2-4 presents five different modes of inter-firm relationships (Contractor & Lorange, 1988; Narula & Hagedoorn, 1999; Mowery et al., 1998):

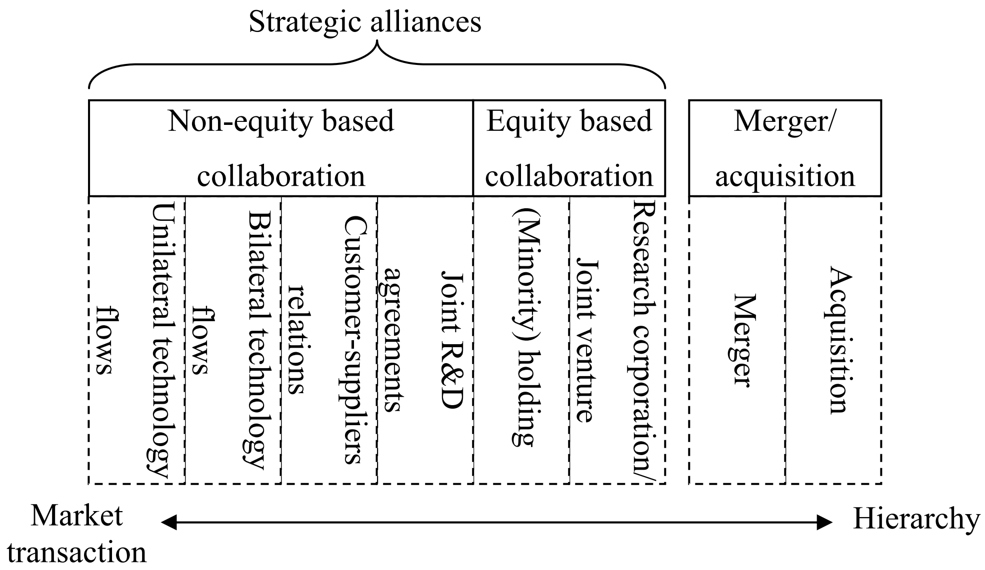

Figure 2-4: Modes of inter-firm relationships
(Adapted from: Bogers, 2004)

i. Contractual agreements (non-equity based partnership), in particular joint R&D pacts and joint development agreements through which companies undertake innovative projects with shared resources; customer-supplier relationships; bilateral and unilateral technological flows;
ii. Joint ventures (equity based partnership), combinations of the economic interests of at least two different companies in a 'distinct' firm that also performs R&D or undertakes innovative projects;
iii. Minority holdings (equity based partnership) combined with technology transfer, where one company has taking a minority share in another company, combined with technology cooperation through a research contract, for instance;
iv. Takeovers or acquisitions, where one company has obtained majority ownership of another company;
v. Mergers, where two separate companies are combined into one company.

The first three modes are strategic alliances (Hagedoorn, 1993), and the latter two are hierarchies in the classical sense of being modes of governance that are integrated into one company. In this research, I only focus on strategic alliance relationships, specifically on minority holding partnerships.

2.5.4 Integration process elements in networks of strategic partners

Williamson's (1975, 1985) theory of transaction costs suggests that exchange relationships can be structured along a continuum of integration ranging from markets to hierarchies. Because it affects the inclusiveness of goals, the locus of decision making, and the scope of supervision and control (Boyle et al., 1992), varying degrees of integration represent important differences in governance (Robicheaux & Coleman, 1994). In particular, integration involves decisions regarding the autonomy of trading partners versus needs for cooperation and authority within the interfirm relationship. Increasing levels of integration can serve to restrict the autonomy and latitude of the trading partners' decision making. Clelland and Finkelstein (1990) show how the interdependence of certain types of organisations in different economic sectors (e.g. equipment suppliers and manufacturers) sets the stage for effective innovation strategies. Granovetter (1985) reviewed the literature and concluded that economic action is embedded in social structure and that this perspective represents an alternative to both the vertical integration and transaction cost perspectives, especially for smaller firms. Osborn and Baughn (1990) sued data on U.S. – Japanese joint ventures and found that the form interorganisational governance takes in international alliances depends upon intentions to conduct R&D, technological intensity, and the sizes of parent companies. As shown, none of the mentioned up research have focused on the integration of NPD project conducted with other partners. However, in the following section, I discuss the two elements of integration processes, communication and coordination in the network context.

2.5.4.1 Communication in network context

Communication is a basic process of organisation. When one conceives the organisation as an ever-changing system of interactions (White, 1992), one notes that communication aids in the development and maintenance of organisational objectives as its members motivate, inform, and inspire each other. Moreover, the employment of hierarchies within organisations for the exercise of control and monitoring, so that objectives may be achieved with some success, is mainly based on communication. It is the 'nervous system' that makes organisations and organisational units cohere and permit their members to coordinate all work efforts.

However, most research in the field of NPD communication, e.g., (Allen, 1977), focuses on communication in project teams inside a single company (Brown & Eisenhardt, 1995).

Currently, it is becoming common for projects to be performed by networks of companies (Badir et al, 2005b). Communication with external partners has been studied by researchers in a variety of settings. See Table 2-6.

Table 2-6: Interorganisational communication in different settings

Authors/year	Settings
Tushman and Katz (1980); Keller and Holland (1983); Ancona (1990)	Communication with the external partners through gatekeepers, communicators, team members
Mohr, Fisher, and Nevin (1996); Millson and Wilemon (2002)	Collaborative communication in interfirm relationship
Monge, Fulk, Kalman, Flanagin, Parnassa, and Sumsey (1998); Hinds and Kiesler (1995)	Interorganisational information and communication technologies infrastructures
Bensaou and Venkatraman (1995)	Information processing needs and capabilities in interorganisational relationships (buyer-supplier)
Sivadas and Dwyer (2000)	Organisational factors influencing alliance success: trust, communication, and coordination
Harvey, Griffith, and Novicevic (2000); Ebadi and Utterback (1984); Czepiel (1975)	Patterns of interfirm communication

In prior research, communication features have been an important variable for understanding the performance of groups (Keller, 1986; Zander, 1979). For instance, the intensity of communication has stimulated active research interests in social psychology, group dynamics, sociology, and in particular in organisational research. Most of that research assumes that a high communicational intensity in groups will create successful task performance. The basic theoretical argument is that groups with a high communicational intensity have more power to induce members to conform to group standards (Homans, 1974). This argument is confirmed in the work of Coleman (1990) and Ellickson (1991), who demonstrated that high communicational intensity has considerable advantages for the creation and maintenance of effective norms in groups. According to these findings, groups characterised by a high communicational intensity are supposed to perform better than groups with less frequent communications.

However, a review of the last four decades of research presents another picture. Lott and Lott (1965) summarised 34 studies conducted between 1950 and 1962 that deal with group task performance as a consequence of communication. The findings are equivocal. Sometimes an increased intensity of communication is associated with increased productivity and improved performance, whereas sometimes there is no relationship, while at other times there is a negative relationship. Several years later, Stogdill (1972) provided one of the best reviews of this literature. He reports that out of 34 studies, 12 indicated positive relationships, 11 indicated no relationships, and 11 indicated negative relationships. On top of that, recent research shows more contradictory results. Mudrack (1989) outlined a summary of research into this relationship. He reports that out of 11 studies, 8 found a positive relationship, two a negative relationship, and with one study no relationship. In two studies (Terborg, Castore, & DeNinno, 1976; Tziner & Vardi, 1982), positive, zero, and negative relationships are reported. Table 2-7 shows the inconsistency of research findings in this domain. The table is not exhaustive, but nonetheless the dissimilarity of outcomes is quite apparent.

Altogether, after forty years of investigations researchers have been unable to generate an understanding of the relationship between communicational intensity and performance that is both intellectually compelling and emotionally satisfying. This research investigates the relationship between the intensity of communication between strategic partners, and tries to discover why high intensity of communication does not always lead to efficient performance, and what factors impact this relationship. It is particularly noteworthy that no study has yet reported the impact of the network lead company's organisational design on communication across a network of strategic partners at the level of NPD projects.

Table 2-7: The effect of intensity of communication on performance

Study/year	Effect on performance
Pelz and Andrews (1976); Farris (1972); Ebadi and Utterback (1984); Keller (1986); Ancona and Caldwell (1992a); Keller (1994); McDonough and Kahn (1996); Hoegle and Gmuenden (1998); McDonough, Kahn, and Griffin (1999)	Positive
Allen and Cohen (1969); Allen (1970)	No effect
Tushman (1978); Cohen and Cohen (1991); Katz and Tushman (1979)	Positive or no effect

2.5.4.2 Coordination in network context

Coordination is the specification and execution of roles with minimal redundancy and variation, and refers to the extent to which different "units" function according to the requirements of other units and the overall system (Mohr & Spekman, 1994). It requires the parties to be competent, reliable, and focused on the mission. It also demands a good measure of empathy because a great deal of coordination is tacit.

The NPD literature points to the significance of coordination as well. The criticality of cross-functional coordination in NPD comes through clearly in Zirger and Maidique's research (1990). They rely on strategic management theory in their propositions that strong R&D, marketing-manufacturing prowess, and coordination are essential for NPD success. Gossain (2003) stated that businesses that coordinate most effectively clearly outpace others in their industries. Lack of familiarity with another unit's procedures and personnel can result in the neglect of some tasks and the needles repetition of others. No one department alone possesses the expertise to develop a product that will meet the requirements of the organisation. Innovators need some mechanism to connect departmental "thought worlds" so that insight possessed by individual departments can be combined to develop new products that harness the collective wisdom of all involved. In the absence of proper coordination, efficiency suffers and goal attainment is delayed or thwarted (Sivadas and Dwyer, 2000). Other authors have made notable contributions to the coordination of activities literature (Coates, et al., 2004; Mintzberg, 1989; Grant, 1996; Jacobides, 2001; Crowston, 1997: Monteverde, 1995; Galbraith, 1973). However, these authors are concerned with within-firm coordination.

The coordination issue is even more problematic in an interfirm context. Sivadas and Dwyer (2000) studied factors for alliance success. They stated that no alliance can succeed unless the partners can coordinate their activities competently. Moenaert and Souder (1990) confirmed that partners have to coordinate their activities in order to successfully achieve the goals of their alliance. Wren (1967) highlighted problems associated with interorganisational coordination. Brouthers *et al*. (1995) studied partner selection, and points out that alliances without coordination and cooperative cultures tend to fail. Clemons and Row (1993) investigated the use of information technology for interfirm coordination activities.

There are different strategies to support the coordination activities with the strategic partners. For instance, in technology acquisitions, structural integration seems to be an appropriate choice (Puranam et al., 2006). Structurally integrating an acquired firm into the acquirer's organisation creates organisational conditions that support the coordinated exploitation of the target firm's technological breakthroughs. By grouping organisational units within common administrative boundaries through structural integration, an acquirer can use common authority, incentives, systems, and processes to simplify coordination and facilitate mutual adaptation. Others analysed M&A and post-acquisition integration of pharmaceutical and biotech companies (Schweizer, 2005).

However, in the case of strategic alliances and networking between independent organisations – which have legally separate identities but are economically interrelated – collaborating on developing a new product, it is almost impossible to have structural integration, as this would assume that one company has a degree of control over the other. Coordination mechanisms other than structural integration have to be developed to support the coordination with strategic partners. *One way of is to adopt an organisational design that supports and promotes the coordination of activities with external partners. Sherman (2004) studied coordination within a firm, and found that coordination deficiency is based on characteristics of the organisational structure that inhibit coordination. He states also that coordination problems result from overburdening formalisation and excessive centralisation. However, no study has yet specifically explored the coordination of NPD project activities across networks of independent partners, or how an organisation might be designed to support this coordination. This is the goal of this research.*

2.6 Conclusion

In this chapter, most of the previous researchers and studies in the fields of NPD management, organisation theory, and interorganisation and networks have been reviewed. The goals of this chapter were: first, to motivate the research question by highlighting the gap in the literature, and secondly, to justify different choices I have made in the research design.

Due to the large body of empirical literature in these fields, I only focus on the most important research works, which have been extensively cited by many researchers. Despite the large amount of research, the literature does not discuss how to achieve the integration between strategic partners, specifically on NPD project level, nor how the organisation impacts the integration process elements across these partners. This research investigates the organisational design of the network lead company on the NPD project's integration process elements with the external partners, and the subsequent effects on performance.

The next chapter will present the theoretical background and the research preliminary model.

3 Theoretical background and research model

This chapter consists of two parts, with the first serving as an introduction to the second. It describes the research context and provides an overview on how a network lead company, in this specific context, can build a cooperative network of high-tech strategic partners. The basic idea springs from the notion that selecting the right partners and integrating their development activities is the first step toward the success of the network.

The second part, which builds on the output of the first, develops a preliminary model of the impact of the network lead company's R&D organisation design on the integration process elements (communication and coordination) with the NPD project strategic partners. The model will be tested later in this research in three case studies.

3.1 Part one: Theoretical background

3.1.1 The NPD process in the organisation context

The best way to view the link between the NPD process and the integration process elements within the organisation context of the network lead company is through an organising diagram, see Figure 3-1. For success, the NPD process requires significant interaction with different levels of an organisation (Thomas, 1993). As shown, the NPD process reacts with two different organisational levels: strategic and operational levels.

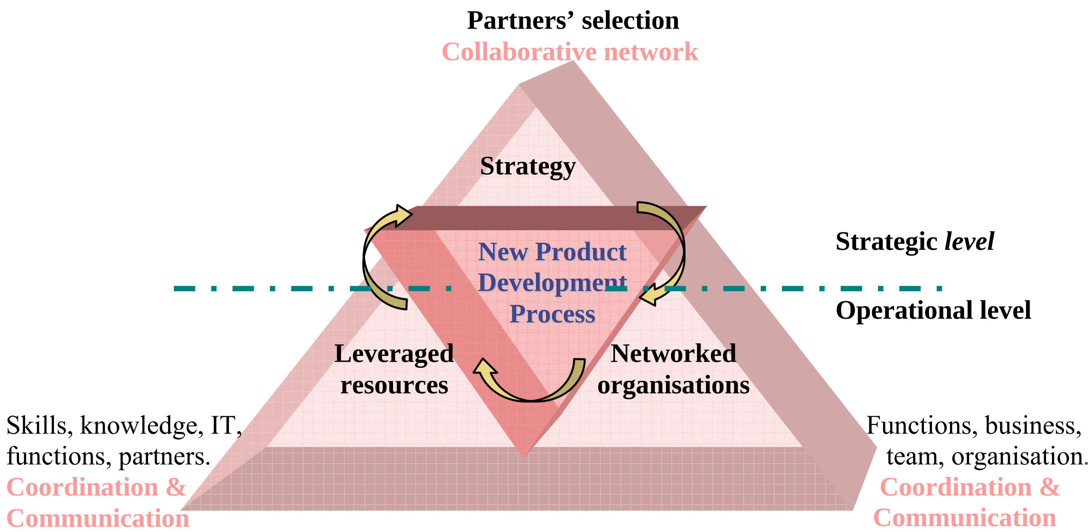

Figure 3-1: NPD process in network lead company organisation context
(Source: Badir et al., 2005a)

At the first level, *the strategic level*, as the limited resources or the need to share risk associated with technological projects force the high-tech companies to collaborate with each other, a decision has to be reached as to which NPD activities should be implemented in-house and which should be outsourced. An important consideration is the strategic relevance of certain technologies for a company. The next important issue is how to select the right partners to execute the outsourced activities. Such decisions are of strategic importance for companies (Badir et al, 2003) and key to the success of their NPD projects.

At the second level, *the operational level*, once the companies have decided what activities to outsource and have selected the right partners, the main questions are: how to build a collaborative network of different-focused organisations to execute the NPD project; what is the best technique to have resources, both tangible and intangible, productively shared among network members; and what approach leads to effective integration of the NPD process activities internally (different units in the network lead company) and externally (with the strategic partners).

The next section discusses how to select the right strategic partners and build a collaborative network of high-tech strategic partners, utilizing a three-phase approach. These three phases are “internal identification,” “partner selection,” and “integration process elements.” It is important to note that this thesis investigate how the network lead company can be organised to support and facilitate the third phase.

3.1.2 The roadmap toward an integration approach

As mentioned in the previous chapter, the integration approach is not something that can be “bought off the shelf” and implemented effortlessly in an NPD process across a network of partners. There are many factors should be considered in order to have an effective integration approach. These include such factors as the network lead company’s strategy, the nature of the NPD project, the characteristics of the network, the available and required resources, and the technology needed.

The proposed integration approach gives the network lead companies a means to design an NPD process integration that fits best into their business and project activities. This approach necessitates several choices by the network lead company management teams. For these choices to be effective, the proposed approach presents a different set of issues at different stages. These issues serve as a roadmap for integrating the NPD process with the strategic partners. As shown in Figure 3-2, our integration approach consists of three different phases: identification, partner selection, and integration elements phases.

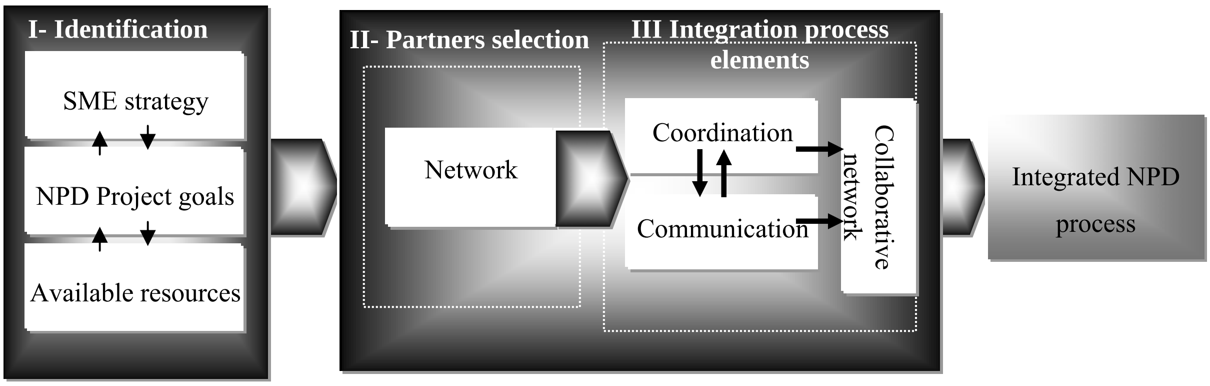

Figure 3-2: Three Phases of integration approach
(Source: Badir et al., 2005a)

The goal of the *identification phase* is to understand the current situation of the network lead company. The results from this phase will be used later on to make the appropriate partner selection. However, the network lead company should identify clearly its vision and its short- and long-term strategies. Most strategists agree that the two key questions of company strategy are what business should the company be in and how to get there (De Wit, & Meyer, 1999). Moreover, the network lead company should also identify the development project goals. The development projects should be in-line with the company's strategy. The third element in this phase is the "internal resource analysis" of the network lead company's resources. This analysis helps to identify the company's specific strengths and weaknesses and its source of competitive advantage.

The second or *partner selection phase* also involves the segmentation of those partners along a spectrum of limited to deep collaboration, based on the strategic importance of the partner. The outcomes from this phase will be used later on to manage the integration process elements (communication and coordination) in the NPD projects. This is because companies generally would not invest a lot of time and effort to communicate and coordinate with non-strategic or unimportant partners. As stated before, no company – especially SMEs – has either the time or resources to develop all the needed capabilities internally. The only way to overcome this obstacle is through collaboration with companies. The strategic partners should meet the following requirement: share the same vision for the business, of great importance to

NPD projects and business, current and future business size matching with the network lead company's plan, can help to have a short-term return on investment, defined long-term potential, and help in improving the NPD process performance.

The third and the most important phase for this thesis is the *integration process elements phase*. It consists of two main elements, coordination and communication with the project strategic partners (these two elements will be detailed in part II of this chapter). For the network lead company, the key to success in this phase is no longer integrating the company's units and activities, but integrating the NPD process across the strategic partners.

The goals of this phase are to ensure that:

i. The people, The people, units, and functions within the network lead company and of the network partners are collaborating effectively for achieving the NPD project goals;
ii. There is a certain degree of which the activities of NPD process across the partners are fitted and linked together in order to accomplish a collective set of tasks, and
iii. The upstream functions have knowledge of network downstream capabilities in order to incorporate these into their activities.

In order to design a good level of integration, the NPD process activities should first be broken out into sub-processes and tasks. This should be followed by finding out the functions of each task; the required input and output of each task; supporting tools, milestones, and deliverables; feed-back loops; and criteria for transition from one phase to another and from one partner to the other.

In the process of breaking out and scheduling NPD process activities, the relationship between the activities of different individuals and the functions of the respective partners will become clear. The next step is to find out where the integration process elements, coordination, and communication are required or have to be enhanced along the process cycle. This step will help to introduce the overlap of activities, which results usually in reducing the time and cost of NPD projects.

Managing the integration of the NPD process across a network of high-tech strategic partners requires a sophisticated organisational design to facilitate and support the coordination of activities and the flow of information across the strategic partners. I argue that no matter how well developed are the integration approaches and mechanisms, they are unlikely to succeed unless the organisational context within which these occur is favourable. Indeed, inappropriate organisational design can be a barrier to integrating the NPD process across strategic partners (Sherman, 2004). This will be the topic of part two of this chapter.

3.2 Part two: Preliminary model

As stated in Chapter One, the primary research question is how the R&D organisation in the network lead company can be designed to support and facilitate the integration process elements with its high-tech NPD project strategic partners. However, unlike the theoretical and empirical literature that exists on the integration of NPD process within a firm, there is little detailed knowledge available about the integration with external partners, and even less on the impact of R&D organisation design on the integration of NPD process across network of high-tech strategic partners. The existing knowledge-base is inadequate, and the available literature provides no conceptual framework or hypotheses of merit. In addition, the mechanisms for integrating NPD process within a firm are different from those connected to integration beyond a firm's boundaries because of the complexity of the network environment, especially in high-tech sectors. This complexity resulted from high uncertainty in high-tech sectors, different company cultures, different communication and coordination mechanisms, trust issues, lack of experience of working together, etc.

There has been developed in this part, a preliminary model of the impact of the network lead company's R&D organisation on the integration process elements with the NPD project strategic partners, and the subsequent effects on project performance, see Figure 3-3. The model will serve as a framework for this study, and will guide the data collection in my empirical research work.

This model contains three principal blocks: (i) the organisational attributes (to be used to design the R&D organisation); (ii) the integration process elements (communication and coordination); and (iii) the project performance (time, cost, and quality). It is worthwhile noting that I relied entirely on the literature to determine what were the integration process elements and the project performance indicators. On the other hand, the empirical research was my sole source for identifying the primary organisational attributes that have greatest impact on the integration process elements and how they related to these elements. In this research I only focus on the integration of NPD processes between the network lead company and its project strategic partners. I do not delve into the integration of NPD process within the company, as there already exists much research that deals with this topic.

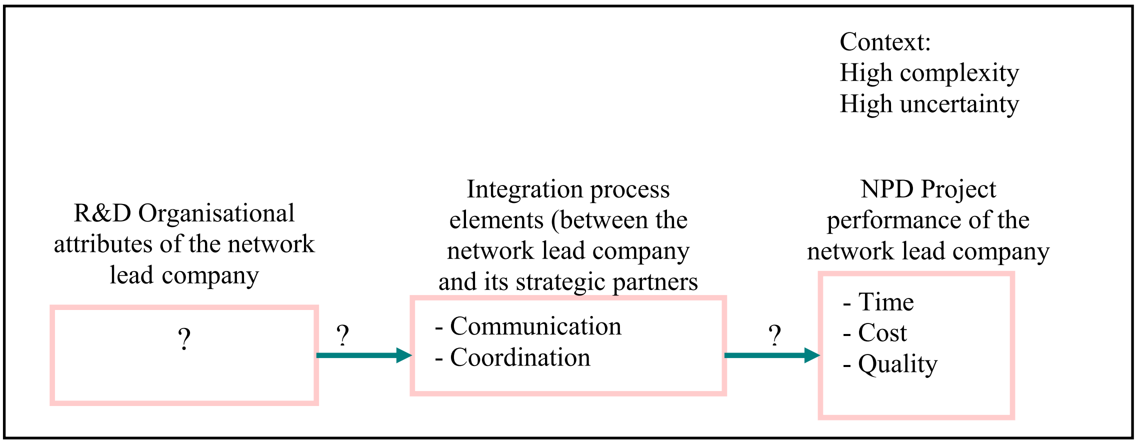

Figure 3-3: Preliminary model of the organisational attributes and its impact on integration process elements

In line with the research question and based on model (Figure 3-3), three main issues will be analysed in the individual case studies. First, I look into the R&D organisation of the network lead companies and try to determine the most important organisational attributes having the greatest influence on integration with the strategic partners. Second, I investigate the positive and negative impact of these organisational attributes on the integration process elements – communication and coordination. Third, I assess the effect of the integration process elements on the NPD project performance. The output of this investigation will be compared with the existing literature, and similarities and differences between my empirical findings and the literature will be surfaced.

3.2.1 NPD project performance

Most NPD projects try to innovate and deliver new products within specific constraints (Clark & Fujimoto, 1989). NPD project performance is high when the actual work matches planned work in terms of cost, time, and quality (Nicholas, 2001). The *cost* of development is the total financial and human resources required to complete the development project. Development *time* is the length of time from concept generation to delivery of the product to market. *Quality* is how well the product meets the demands of target customers (Sheremata, 2000).

These three dimensions of performance are highly interrelated. Shorter development times can lead to higher or lower development costs, and to lower-quality products (Kessler &

Chakrabarti, 1996). Other researchers argue that the relevant issue is not so much predicting one dimension as predicting one while holding the other two constant (Clark & Fujimoto, 1989). However, the real challenge is to create better product, faster, and at less cost (Wind & Mahajan, 1997). The high degree of complexity and uncertainty in high-tech NPD projects makes it more difficult to meet these goals, and increases the interdependence between project partners as they face a situation of mutual vulnerability. This interdependence calls for efficient integration of the NPD process to improve overall NPD project performance (Batt & Purchase, 2004; Cheng et al., 2004; Parker, 2000; Perona & Saccani, 2004).

3.2.2 Integration process elements

In much of the NPD literature, the term 'integration' is used to describe a variety of cross-functional linkages. It refers to the coming together of diverse interests and people to achieve a common purpose (Jassawalla & Sashittal, 1998; Song et al., 1997). Lawrence and Lorsch (1986) define integration as the process of achieving unity of effort among the various subsystems to accomplish the organisation's task. The Product Development and Management Association (PDMA, 2002) defines integrated product development as a philosophy that systematically employs an integrated effort of a team from multiple functional disciplines to develop effectively and efficiently new products that satisfy customer needs.

The importance of organisational integration has grown dramatically in recent years as evidenced by the increased number of articles in scholarly journals focusing on integration as an independent or dependent variable (Millson & Wilemon, 2002). Some researchers have studied its impact on product market success (Kok et al., 2003) and development performance (Nohria & Ghoshal, 1997). Gupta *et al.* (1986) researched organisational integration in their analysis of marketing and R&D departments in high-tech firms. Their goal was to ascertain the impact of integration on innovation success and the attainment of overall organisational goals and objectives. Ruekert and Walker (1987) extended the research of Lawrence and Lorsch (1967) and Gupta *et al.* (1986) by investigating the effects on market success of integration among business functions such as accounting and manufacturing, in addition to marketing and R&D.

Several studies found integrating NPD activities to be an effective way of overcoming problems related to long development lead times, inefficient manufacturing processes, and product found to be below customer expectations (Clark and Fujimoto, 1991). By working in an integrated fashion, there is a good chance that:

i. Development cycle time and cost may be reduced because less reworking will need to be done because different functions in different organisations will carry out their work with due regard for the relationships between the various parts, components, and production processes
ii. Product quality may improve because a product's parts and components will be designed as a whole rather than as separate entities.

In addition, a well-integrated process leads to a systematic transition so that one function's output becomes another function's input at the right time; this may result in seamless transferral between activities.

Several mechanisms and approaches for NPD process integration have been put forward in the theoretical, empirical and descriptive literature (Birou & Fawcett, 1994; Mintzberg et al., 1995; Moenaert & Souder, 1990). Most of these works focus on two elements: *communication* between development team members (Sivadas and Dwyer, 2000; Millson & Wilemon, 2002; Nohria & Ghoshal, 1997; Paashuis, 1998; Mohr et al., 1996) and *coordination* of resources and activities (Badir et al., 2005a; Perona & Saccani, 2004). In this research, and in line with the literature, the integration process elements are defined as a combination of communication and coordination processes between different functional areas across the network of strategic partners.

3.2.2.1 Communication

Communication is the process by which information originating in one function (sender) is transferred to and utilized by another function (receiver) (Moenaert and Souder, 1990). In other words, output information of one function is transferred to serve as input information for another, with input as well as output information comprising knowledge and know-how, including ideas, concepts, data, results, analyses and plans (Badir et al, 2005a). In this process, people from different functional areas – within or across organisations – share and understand information, usually with the intent to motivate or influence behaviour. I define communication here as the extent to which the network lead company's NPD project team communicates and shares information with the strategic partners' teams participating in the project. Internal communication within the network lead company is not the focus of this study.

Communication flow is one of the integration processes that animate the network. This includes lateral and vertical as well as formal and informal communication flow (Galbraith, 1973). The ultimate aim of communication is to ensure that the right information is sent to the right place at the right time (Badir et al., 2003). Communication is enabled and facilitated by meetings, committees, telephone calls, standard forms, memoranda and reports, emails, and information systems. It is also considered as a multidimensional phenomenon that can be conceptualised across a number of attributes, including frequency, mode, informality, openness, density, content, pattern, and directionality (Gupta & Govindarajan, 1991; Nohria and Ghoshal, 1997).

Communication and information processing are key aspects of NPD projects (Smith & Reinersten, 1991). For example, new products are frequently conceptualised and implemented in response to market intelligence. The faster information can be processed, the faster new products can be developed (Wheelwright & Clark, 1992). Networks of strategic partners are experiencing more than ever the need to communicate better in order to develop new products more rapidly to satisfy expanding and changing customer requirements in light of new technologies and intensifying global competition (Millson & Wilemon, 2002; Millson et al., 1992). Anderson and Narus (1990) have found a strong positive correlation between the level of communication between firms and the success of their collaboration in developing new products. Sivadas and Dwyer (2000) state that effective communication between partners is essential for alliance success. Mohr and Spekman (1994) find that successful partnerships exhibited better communication and information sharing.

As uncertainty in a high-tech NPD project increases, the amount of communication and information processing during the execution of activities increases also (Oorschot, 2001). Badir *et al.* (2003) indicate that some of the fundamental reasons for failure to achieve project goals according to the set time, cost and quality are:

i. Lack of awareness of what other strategic partners' teams on the project are doing
ii. Poor reactivity to sudden changes in the project environment
iii. Lack of discipline in controlling design changes.

They argue that these problems stem from communication.

3.2.2.2 Coordination

Coordination entails linking different but interdependent parts of an organisation to work together in the accomplishment of defined goals (Bailetti et al., 1994; Clark & Fujimoto, 1991; Mintzberg, 1989). Malone and Crowston (1994) define coordination as the act of working together. In the network environment, coordination between project partners becomes a strategic issue (Badir et al., 2003; Perona & Saccani, 2004).

From the perspective of coordination theory, the NPD process consists of three types of elements: *resources*, *activities,* and *dependencies*. A resource is produced and/or consumed during a process. An activity is a partitioned action that produces and/or consumes resource(s). A dependency is a relation among activities mediated by producing or consuming resources(s) (Malone & Crowston, 1994; Olson et al., 2001). In this research coordination refers to the degree to which the activities of the NPD process fit and are linked together (Van de Ven, 1976); the resources are shared (Badir et al., 2005a; Olson et al., 2001); and the dependencies are effectively managed (Malone & Crowston, 1994) in order to accomplish a collective set of tasks in the NPD project.

Indeed, a major challenge in managing the NPD process is achieving the effective coordination of its constituent activities and resources (McChesney & Gallagher, 2004). Within their own context, individual organisations may well have sufficient knowledge and skills to do a good job, but unless these are sufficiently coordinated with the project partners, a project could still fail (Moenaert & Souder, 1990). Sivadas and Dwyer (2000) state that no alliance can succeed unless the partners can competently coordinate their activities. Not having a well-coordinated development process can have a negative effect on lead time, cost, and product quality. NPD activities, therefore, require a certain level of coordination because individuals and functions of the respective partners often lack the knowledge and skills to take into account all relevant development issues, especially those outside their specialist areas. It is important for the network of strategic partners that the upstream functions coordinate with downstream capabilities along the NPD process in order to improve project performance.

3.2.2.3 Output of communication and coordination with strategic partners

The result of well integrated NPD process activities is improved project performance (time, cost, and quality). This can be explained in the following:

i. *Reducing the development cycle time*: because high levels of flow of information and knowledge sharing lead to availability of data and information needed by project members to make decisions (speeding up decision making). In addition, there is a significant reduction of the project development cycle time due to overlapping of activities. Furthermore, good communication and coordination allow the project teams to identify and solve problems while they are small. This eliminates or reduces conflict between project members, which is one of the main reasons for project delay.
ii. *Improving product quality*: as the project's teams, up-stream and down-stream, become aware of the tasks that have to be accomplished collectively and the functions and capabilities of each other.
iii. *Reducing NPD project cost:* due to less re-work or repetitive work.

3.3 Conclusion

This chapter comprised two sections: The first described the research context and presented how network lead companies build their network of strategic partners. The goal was to introduce the research topic.

In the second, I developed a preliminary model of the impact of the network lead company's R&D organisational design on the integration of the NPD process with the strategic partners, and the subsequent effect on project performance. This generic model will serve as a framework for this study, and will guide the data collection in my empirical research work. As shown in the model, three main issues will be investigated: (i) the main organisational attributes that have the greatest influence on the integration process elements; (ii) the relationship between these attributes and the integration process elements; (iii) the effect of integration process elements on the NPD project performance.

The next chapter, which deals with the research methodology, provides the means to validate this model in the empirical research.

4 Research methodology, operationalisation, and analysis

4.1 Introduction

In the previous chapter, a theory-based preliminary model was developed. The primary purpose of the theoretical model is to provide a basic framework to guide the research design and data collection. Chapter 4 deals with three main topics: (i) the empirical research design, explaining why case studies are the appropriate research method when considering organisation design and its impact on the integration process elements (communication and coordination); (ii) the operational measures of the main constructs; and (iii) the data analysis methodology adopted in this research.

4.2 Research design and method

The research design is the logical sequence linking the empirical data to the study's initial research questions and, ultimately, to its conclusions (Yin, 1994). In research design, choices have to be made as to the way in which data will be collected (research method and means of empirical data collection), the aspects on which data will be collected, and the practical environment in which data will be collected (research domain).

4.2.1 Why qualitative research

Since too little detailed knowledge is available on the effects of organisation design on the integration of NPD process across a network of strategic partners, a considerably detailed approach is called for. Eisenhardt (1998) stated that such circumstances require a research approach in which the generation of new knowledge and improved understanding take place by iterating between the data and the existing body of knowledge.

Miles and Huberman (1994) suggested that researchers should use qualitative research design when there is a clear need for deep understanding, local contextualisation, causal inference, and exposing the points of view of the people under study. The arguments in the last section clearly demonstrate that these needs apply in the case of studying the impact of organisational design on the communication and coordination between NPD project strategic partners whose competitive advantages and organisation capabilities are embedded in their specific cultural and local context.

For the same reason (limited knowledge on this subject), a detailed definition of the hypotheses to be tested was not possible at the outset of the study. Consequently, instead of testing pre-defined hypotheses, the study aims at generating propositions for future research. The aim is to increase this knowledge by exploring, describing, and explaining the complex relationships among some organisational attributes and the integration process elements, and the impact of these relationships on the NPD project performance.

4.2.2 Why case study

As mentioned in Chapter 1, the central research question in this study is how can the network lead company design its R&D organisation to support the NPD project's communication and coordination activities with the project strategic partners and improve project performance. *A*ccording to Yin (1989), case studies are preferred when "how" or "why" questions are being posed.

In earlier research, Larsson (1990) argued that case studies are particularly appropriate for the study of integration related issues, given the need for detailed, contextual descriptions of very sensitive data. Yin (1993) stated also that to investigate a complex interaction between a phenomenon and its context, as with interorganisational partnerships, the case study is the method of choice. The case study methodology permits the researcher to retain the complexities and holistic nature of the phenomenon under study (Yin, 2003). The use of case studies in this context is also in line with the recommendations of Bower (2004), Javidan *et al* (2004) and Schweizer (2005). Hence, the appropriate research methodology for a study that attempts to extend existing NPD integration and organisation management literature is the comparative case study research methodology (Eisenhardt, 1989; Lee, 1999; Yin, 1984).

In this research, however, the case study approach has been selected for the following two reasons:

i. The subject of study is not well known and not all variables that play a role can be identified beforehand. Therefore, a more holistic view is required in which wide range of variables may be taken into account;
ii. Not only is it of interest to know what organisational attributes support the integration of NPD process with the strategic partners, but also how these attributes can support the integration, and under what conditions. This necessitates more in-depth research.

Three detailed case studies from three different high-tech sectors – electronics, biotechnology, and mechanics – are undertaken of organisation design and its impact on integration of NPD process implemented throughout the dispersed activities of a network of partners. The case studies serve twin purposes:

i. Identifying primary organisational attributes (to be used to design the organisation) that have greater influence on the integration with the strategic partners; and
ii. Uncovering the relationship between these attributes and the integration process elements, and the subsequent effect on project performance in this specific context.

4.2.3 The role of the preliminary model in the case study

An analytical strategy should guide data collection (Yin, 2003). In the previous Chapter, a theory-based preliminary model was developed to guide the design and data collection for case studies. Reliance on this theoretical concept remains one of the most important strategies for completing successful case studies. Such theoretical concept can be useful in conducting exploratory, descriptive, or explanatory case studies.

The goal is to develop preliminary concepts at the outset of a case study. As with any other empirical study, one purpose served by such concepts is to locate the case study in an appropriate research literature context, so that lessons from the case study will more likely advance knowledge and understanding of a given topic. A second purpose, possibly more important for case studies than for other types of research methodologies, is to help define the unit of analysis (What is the case?), to identify the criteria for selecting and screening potential candidates for the cases to be studied, and to suggest the relevant variables of interest and therefore data to be collected as part of the case study (Eisenhardt, 1989). Without guidance from the theory-based preliminary model, all these choices may be extremely difficult and hamper the development of a rigorous case study. Good use of theory will help delimit a case study inquiry to its most effective design. The theory is also essential for generalising the subsequent results.

In addition, *a priori* specification of constructs can also help to shape the initial design of theory-building research. Although this type of specification is not common in theory-building studies to date, it is valuable because it permits researchers to measure constructs more accurately. As the study progresses, if these constructs prove important researchers have a firmer empirical grounding for the emergent theory (Eisenhardt, 1989). In line with that, I identified the constructs (communication, coordination, and project performance) of the preliminary model (Figure 3-3) based on process integration and project performance literature. The constructs were explicitly measured in the interview protocol. The operationalisation of these constructs is discussed in section 4.3. However, it is important to mention that although early identification of the research questions and possible constructs is helpful, it is equally important to recognise that both are tentative in this type of research. No construct is guaranteed a place in the resultant theory, no matter how well it is measured.

4.2.4 Cases selection

Selection of cases is an important aspect of building theory from case studies. As in hypothesis-testing research, the nature of the study population is crucial, because the population defines the set of entities from which the research sample is to be drawn. Also, selection of an appropriate population controls extraneous variation and helps to define the limits for generalising the findings (Eisenhardt, 1989). Moreover, the sampling of the case studies is essential, as sample selection influences the results of a study (Miles &Huberman, 1994).

A new-to-firm development project at the researched companies — one each from the electronics, biotechnology, and mechanics sectors — has been selected for detailed investigation. The companies were selected on the basis of the following criteria:

i. The companies pioneer roles in revolutionising their industry (industry leaders);
ii. High rate of high-tech new product launching (innovative);
iii. Deep experience in working with strategic partners to develop new products (acknowledged importance of partner involvement in development activities);
iv. Focal position in the network (a network lead company);
v. Medium-sized (about 5000 employees); and
vi. Swiss-based (head-quartered in Switzerland) and performing internationally.

These six criteria are important to ensure that the three cases are aligned, resulting in the reduction of extraneous variation. However, the three companies differed along one main dimension, the development cycle time (DCT), due to kinds of products developed by each. This enabled the researcher to control the NPD projects' characteristics variation.

4.2.4.1 Type of strategic partnerships to be studied (Equity-based partnerships)

Generally, a company (network lead companies, for purposes of this research) makes equity investments in other partners because of their importance to that company's business. This equity-based partnership, which ranges from minority holding to joint venture, establishes a certain level of trust between partners – especially when an executive of the network lead company is appointed to its partner company's board of directors. This trust relationship facilitates the more open sharing of sensitive and important information, tangible and intangible resources, team skills, experience, etc., with the expectation of producing a positive impact on the level of intensity of communication and coordination between partner companies. Gulati (1998) stated that trust not only enables greater exchanges of information, it also promotes ease of interaction.

On the other hand, other types of partnerships (see section 2.5.3) may not guarantee the necessary trust. There will always be an apprehension that the partner may become a direct or indirect competitor, or that the partner may provide other competitors access to the latest technology developed with the network lead company. Consequently, communication and coordination will be restricted, resulting in a negative impact on their intensity level. Because of this, the level of communication and coordination that exists with equity-based partnerships is not the same as that of non-equity-based partnerships. This research focuses on communication and coordination between the network lead company and its partners, specifically those in whom the network lead company has equity investments (minority holding).

The only drawback to this kind of partnership is that, over time, the partners begin to know instinctively what each expects and requires from each other. This is especially true when it comes to incremental innovative projects, where most activities to be executed are already known. This may lead to a lower level of communication and coordination between the partner companies, which means that for the researcher, unfortunately, the amount of empirical data to be analyzed is diminished. To overcome this drawback, I investigate new-to-firm projects in this research, with the assumption that these involve a high intensity of communication and coordination between partner companies, given that they are conducting the project for the first time.

4.2.5 Data collection

Case study research is characterised by the analysis of various sources of primary and secondary data that help to develop a theory (Eisenhardt, 1989). Following Yin's (2003) advice, I have sought to combine many sources of evidence to tackle a broader range of historical, attitudinal, and behavioural issues; it also facilitates the development of converging lines of inquiry. The use of multiple sources is actually an excellent technique for performing data triangulation (Patton, 1987), i.e., to have different sources of information for the same data. If the sources of evidence were contradictory rather then corroboratory, I investigated the problem by inquiring further into the topic.

Examples of primary data used for the present study are interview transcripts, feedback reports, telephone conversations, and emails. Examples of secondary data are company annual reports, brochures, product catalogues, press releases, and newspaper articles pertaining to the new product.

4.2.5.1 Interviews

The main means of obtaining empirical data in this research are *semi-structured interviews*. Interviews are en essential sources of evidence because well-informed respondents can provide important insights into situations. Furthermore, *since organisation context and integration efforts are largely about human interaction, people's interpretation of events should play an important role* in this case study research.

During the period from February to October 2004, the multiple-case research design involved nine semi-structured interviews with R&D directors, business unit directors, product line directors, and NPD project managers from the three companies (Appendix A). At least three people from each company were interviewed, with each interview lasting approximately two hours. The communication continued with the interviewees, mainly by phone conversation and emails, over one year. The questions were developed based on an extensive literature study and the preliminary theoretical model developed in the previous chapter. Different questions were asked depending on the interviewee's hierarchical and functional position in the company (see Appendix B for questions directed to NPD project managers, and Appendix C for questions directed to R&D directors). Whenever appropriate, additional questions not from my scheduled list were asked. I focus on the most recent NPD project interviewees worked on with external partners that has been completed by their respective companies. Data was collected regarding three main topics: the R&D organisation, the NPD project, and the communication and coordination activities with the external partners. Additional contact with the interviewees, to clarify some points and gather further data about others, was primarily via email and phone conversations. Some points have to be clarified and in some cases, more information about specific pointed was required.

All the interviews were tape recorded and transcribed as soon as possible, in most cases within two or three days following the interview. The transcript of the full interview was returned to each individual interviewed to make sure the material was an accurate representation of the interview.

4.2.5.2 Secondary source of data

Documents are a rich source of data. These secondary sources of data include annual reports, financial statements, press releases, newspapers articles, and a company's Web site. They are used for collecting information at the organisation level. At the project level, the main secondary sources of data include minutes of meetings, NPD project proposals, project progress reports, activity schedules and budgets, and quality handbooks.

4.2.6 Analytical generalisation

Case studies may seem weak in their capacity to generalise because time constraints limit the number of cases that can be studied. However, case studies may have an advantage over quantitative studies; the detailed examination of processes in context can reveal processes that can proposed as general or peculiar to a specific organisation. This is yet another reason that case study research is the most appropriate methodology for this research; i.e., the detailed knowledge about the organisation and about the integration process elements and its context can help to specify the conditions under which the behaviour can be expected to occur. In other words, the generalisation is about theoretical propositions, not about populations. If two or more cases are shown to support the same theory, replication may be claimed, thus ensuring the external validity of the case study's findings. Yin (1989) calls this line of reasoning analytic generalisation: the striving to generalise a particular set of results into some broader theory. In consequence, the basis of the generalisation is not primarily about the typicality of the organisation, but rather about the existence of particular processes that may influence behaviour and actions in the organisation.

Because case studies rely on analytical generalisation instead of statistical generalisation, a large sample is not required; i.e., a number of companies that are representative of the entire population (Yin, 1994). The aim of analytical generalisation is to develop a theory, not, for example, to statistically prove a relation between two phenomena. Some authors argue, therefore, that only a small number of cases are required to achieve analytical generalisation (Yin, 1994; Miles, 1984). Thus, three new-to-firm development projects, led by three different thigh-tech network lead companies from different industries, were chosen for this study. Moreover, in order to strengthen the findings from the case studies, I conducted several interviews with eleven project managers and R&D directors working in other high-tech companies (Appendix D).

4.3 Operationalisation

In this section, I consider how the research question will be investigated in the case studies, and I describe how I operationalise and measure the constructs of the model developed in the previous chapter. It should be noted that I only operationalise and measure the dependent variables (communication and coordination) and output of the model (NPD project performance: cost, time, and quality). This operationalisation and measurement are based on the literature, and have been modified to meet the specific characteristics of the research question, the context, and the case studies. The independent variable (organisational attributes) will surface in the "case studies results" in Chapter 6. The operationalisation and measurement of these attributes will also be described in Chapter 6, where the construct, its definition, and measurement will emerge from the analysis process itself, rather than being specified *a priori* (Eisenhardt, 1989; Miles and Huberman, 1994).

4.3.1 Dependent variables

In this section, I operationalise and measure the dependent variables, which are the integration process elements (communication and coordination) between the NPD project team of the network lead company and the project strategic partners. I investigate the average intensity of communication and coordination with the three most important strategic partners, specifically those in whom the network lead company had equity investment (minority holdings).

4.3.1.1 Operationalisation and measurement of communication

The main goal of communication between the NPD project team of the network lead company and its strategic partners is to ensure that the right information is sent to the right place at the right time. I operationalise this construct as the following: *the extent to which the NPD project team of the network lead company communicates (on task- or work-related matters) and shares information with the strategic partners' teams participating in the project*.

There are different methods for measuring communication. For instance, Nohria and Ghoshal, (1997), Allen (1977), and Ancona and Caldwell (1992) measured the frequency of communication, Hong Paul (1999) measured the knowledge sharing, while Sheremata (2002) and Moenaert and Souder (1990) measured the flow of information between groups. However, most of these measurements were developed to assess communication within a firm.

In this research, I investigate the intensity of the verbal and nonverbal communication between the network lead company's NPD project team and the project strategic partners. To ascertain the intensity of communication, I measure the frequency of communication (verbal communication) and the rate of flow of information and knowledge sharing (nonverbal communication). Table 4-1 presents a summary of the measurements used to assess the intensity of communication between the focal company's project team and the teams of the strategic partners participating in the project.

Table 4-1: Measures of the communication construct

Intensity of communication activities between NPD project team of the network lead company and the project strategic partners
I- Verbal communication (frequency of the following types of communication media): - Face-to-face meeting - Video conference - Phone calls - Email exchange
II- Nonverbal communication: the rate of flow of information and knowledge sharing between teams (reports, data, studies, plans, etc).

4.3.1.2 Operationalisation and measurement of coordination

In line with the coordination theory, I operationalise the intensity of coordination activities as the rate to which the resources are shared (Olson et al., 2001; Badir et al., 2005b) between the network lead company's NPD project teams and its strategic partners; and the amount of effort and time spent on managing dependencies between the NPD activities (Malone & Crowston, 1994) in order to accomplish the project within the plan. Table 4-2 presents how I assess and measure the intensity of coordination activities in the case studies.

Table 4-2: Measures of the coordination of activities

Intensity of coordination activities between NPD project team of the network lead company and the project strategic partners
I- The rate of resources sharing between partners (e.g. monthly bases). - Tangible resources: manufacturing or processing facilities, marketing expertise, technology or R&D expertise, general management and support services, capital. - Intangible resources: team skills, knowledge and experience.
II- The amount of efforts and time spent on managing the dependencies (interdependence) of the activities.

4.3.2 Operationalisation and measure of the model output

The NPD project performance is gauged according to the traditional criteria of cost, schedule, and technical performance. In order to assess the NPD project performance, I compare the actual development with the initial project plan (Sheremata, 2002).

4.3.2.1 Development time

The extent to which actual availability of the product was later than the first target date for availability committed to by management.

4.3.2.2 Development Cost

The extent to which the actual development cost of the new product met the first target cost commitment to by management.

4.3.2.3 Quality (product quality attainment)

The average of functional and reliability attainment

i. Functional attainment: the extent to which high-level functional objectives were attained,

ii. Reliability attainment: the extent to which high-level reliability objectives were attained.

4.4 The analysis

Data analysis is the core of building a theory from case studies. It is, however, both the most difficult and the least codified aspect of the process (Eisenhardt, 1989). In research methodology literature, several key features of analysis can be identified: First, there is within-case analysis. It typically involves detailed case study write-ups for each study site. These write-ups are often simply pure descriptions, but they are central to the generation of insights (Gersick, 1988) because early in the analysis process they help researchers cope with the often enormous volume of data. However, there is no standard format for such analysis. The overall idea is to become intimately familiar with each case as a stand-alone entity. This allows the unique patterns of each case to emerge before investigators push to generalise patterns across cases. In addition, it gives investigators a rich familiarity with each case which, in turn, accelerates cross-case comparison.

Coupled with within-case analysis is cross-case search for patterns. A key to good cross-case comparison is considering the data in many divergent ways (Eisenhardt, 1989). One tactic is to select categories or dimensions, and then to look for within-group similarities combined with inter-group differences.

In this research, I have employed both within-case and cross-case analyses. First, I categorised each case into three different but related levels (units of analysis): the *company*, the *R&D,* and *NPD project levels*. The company level presents a profile of the company: company history and milestones; organisation and management; business overview; the industry; comparison of company with competitors; and the company's strategic partners. The R&D level presents the organisation, structure, and management of the R&D activities. Finally, the NPD project level considers the following: the general model of the NPD process; an actual new product development project conducted by the R&D organisation with active participation from the strategic partners; the integration process elements between the project development team and its strategic partners; and the NPD project performance.

Next, I look for within-case and cross-case similarities and differences. This is done by examining, categorising, and tabulating evidence to address the initial propositions and to find the relationships between organisational attributes and integration process elements (communication and coordination) with the project strategic partners.

Finally, I compare systematically the emergent framework with the evidence from each case in order to assess how well or poorly it fits with case data. My goal here is to constantly compare theory and data. A close fit between the theory and data is important for building good theory because it takes advantage of potentially new insights that emerge from the data, and yields an empirically valid theory. Yan and Ray (1994) used this method in their examination of bargaining power, managerial control, and performance of US – Chain joint ventures. Parkhe (1993) has argued that the comparative case method is particularly well suited for partnerships such as joint ventures due to the need for theory development.

4.5 Conclusion

This chapter presented the empirical research methodology utilised in this research. Due to the nature of the research question and the limited detailed knowledge available about this topic, a case-study research methodology was selected as the appropriate investigation tool. The case studies serve a dual purpose: (1) identifying primary organisational attributes that have greater influence on the integration with the strategic partners; (ii) uncovering the relationship between these attributes and the integration elements, and the subsequent impact on project performance in this specific context. The operational measures and methods of data collection and data analysis were also presented. In the next chapter, the three case studies will be described in detail.

5 Case studies

5.1 Introduction

In this chapter, three detailed case studies are presented. They are high-tech companies operating in different sectors: electronics, biotechnology, and mechanics. Each of them is leading new product development (NPD) projects, with input from its strategic partners.

The first case study is Company-A, which is active in the electronics industry. The study focuses on an NPD project called the "io-Digital-Pen" project. The second case study is Company-B International S.A., which is a leading company in the biotechnology industry. An NPD project (from the Reproductive Health (RH) business unit) called ORA has been targeted for further investigation. The third company, the Company-C, is in the mechanical industry. A development project of a new high-tech machine called "Mistral project" is investigated in this study.

Each case study is classified into three different but related levels: the company level, the R&D level, and the NPD project level. The company level focuses on the company background, the history and milestones of the company, business overview, the industry, the company versus its competitors' situations, the organisation and management of the company, and the company's strategic partners. The R&D level focuses on the management, structure, and organisation of the R&D activities. The second level, the NPD project level, presents and describes the general model of the NPD process at the company, actual new product development project conducted by the company with active participation from the strategic partners, the integration process elements between the project development team of the company and its strategic partners, and the NPD project performance.

5.2 Company-A case study

Even though we might soon be a one-billion-dollar company, I still look at Company-A as being a small company, made up of business units, each of them having to survive in this world. Each of them acts or should act like a start-up. In a start-up, the reason to be is only to innovate; so, for us, innovation- and I would even extrapolate for many companies nowadays- is the way to survive. The Co-founder and Chairman of the Board, 2002.

5.2.1 Company background

5.2.1.1 History and development of Company-A

Company-A International is a Swiss public company, founded in 1981, with corporate headquarters through its U.S. subsidiary in California, and regional headquarters through local subsidiaries in Switzerland, Taiwan, and Hong Kong. The company traded on the Swiss Exchange under the symbol LOGS in 1988, and on the Nasdaq National Market under the symbol LOGU in 1997. The company has manufacturing facilities in Asia and offices in major cities in North America, Europe and Asia Pacific. At present, the company employs more than 6'500 people worldwide.

Company technology

Company-A products are sophisticated systems that combine multiple engineering disciplines – lightweight radio frequency transmission, optical, mechanical, electrical, acoustical and software – and incorporate both cognitive and physiological elements in user-centric industrial designs. These systems share common design elements, including: sensors to detect and encode motion, images, sound or other analog data into electrical signals; custom ASICs; microcontrollers to convert and process signals received from the sensor; a communications subsystem to exchange signals with an attached computer or other intelligent host; and a suite of driver, utility and user interface software modules and Web sites. The Company believes the software modules and Web support complete a seamless user-centric solution for information input, access and control.

Acquisition strategy at Company-A[1]

In September 1998, the Company acquired the QuickCam® PC video camera business of Connectix Corporation for $26.2 million, including closing and other transaction costs. The acquisition was consistent with the Company’s strategy to pursue new areas of growth and enter the PC video camera market. The Connectix business has been integrated into the Company’s video division. The acquisition allowed the Company to take advantage of the new technologies in digital imaging and the growth of the market for PC video cameras. With the success of its line of PC video cameras, the Company has emerged as a market leader in this product category.

[1] Adopted from: Company-A financial review 2004

In March 2001, Company-A acquired Labtec Inc., a provider of PC speakers, headsets and microphones based in Vancouver, Washington, for $73 million in cash and stock, and $3.3 million in transaction costs. The acquisition strengthened Company-A's market presence in the audio interface space.

Subsequent to year-end, the Company acquired Intrigue Technologies, Inc., a privately held Canadian company focused on advanced remote control technology. Company-A paid cash consideration of approximately $29 million for all the outstanding shares of Intrigue Technologies. The acquisition is part of the Company's growth strategy to position Company-A at the convergence of consumer electronics and personal computing in the living room. With its knowledge and experience in control devices for the PC and game consoles, combined with Intrigue's expertise and know-how in advanced remote control technology, the Company believes it is well positioned to further its presence in the digital living room.

5.2.1.2 Company milestones

Since its inception more than two decades ago, Company-A has consistently led the industry in innovation and product design. Table 5-1 shows a list of product introductions and company milestones.

5.2.2 Business overview

5.2.2.1 Company overview

Company-A is a leader in the design, manufacture and marketing of personal interface products for personal computers and other digital platforms. The Company's product family includes webcams, mice, trackballs, and keyboards for the PC; interactive gaming controllers, multimedia speakers and headsets for the PC and for gaming consoles; mobile headsets; 3D control devices; and with its recent acquisition of Intrigue Technologies, advanced remote controls.

Table 5-1: Company-A milestones from 1981 to 2004
(Adapted from: Company-A annual reports 2002, 2003, and 2004)

Year	Description of events
1981	Company-A founded by two former Stanford graduate students
1982	Introduces opto-mechanical technology. The Company-A P-4 combines the reliability of optical mice with the operational convenience of mechanical mice without the need for a special mouse pad.
1983	Develops a mouse for the Apple® Lisa® computer, ancestor of the Macintosh
1984	Introduces the first cordless mouse, which uses infrared technology
1985	Enters the retail market and introduces the first mouse priced under $100
1987	Develops opto-mechanical tracking technology
1989	Introduces the first thumb-operated trackball
1989	Launches the Series 9 mouse, the first "hand-fitting" mouse
1991	Debuts the first cordless radio mouse
1991	Introduces the first mouse designed especially for children ("Kidz Mouse")
1992	Unveils debuts Magellan® 3D mouse for virtual reality and 3D CAD/CAM/CAE applications
1995	Launches first optical trackball
1996	Milestone: 100 million mice sold
1997	Begins selling the first USB peripheral
1998	Introduces first PC video camera with integrated microphone
1999	Milestone: 200 million mice sold
1999	Mice and keyboards become "Internet peripherals" with the introduction of Company-A's iTouch™ software
2000	Milestone: 300 million mice sold
2001	Unveils the first cordless optical mouse
2001	Acquires Labtec, founds Audio Business Unit
2002	Milestone: 400 million mice
2002	Introduces the first mouse with twin optical sensors
2002	The introduction of the first mouse to use Fast RF Technology and an optical sensor capable of capturing up to 4.7 megapixels of surface tracking info/sec. Also, launched the io-Digital-Pen.
2003	Company-A ships its 500 millionth mouse
2004	Acquires Intrigue Technologies, maker of the Harmony Remote
2004	Company-A ships its 50 millionth cordless peripheral for PCs

The Company's retail products increasingly target and appeal directly to consumers and businesses as they purchase add-on devices for their PC or gaming console. Company-A's products are purchased as add-ons for enabling applications that require dedicated devices, including webcams, PC headsets, steering wheels and joysticks for PC and console games. The products are also purchased to replace the basic peripherals that originally came with the PC or game console with devices that offer increased comfort, flexibility and functionality. Company-A's OEM products are a frequent choice among PC manufacturers, who need high-quality, affordable, and functional personal interface products in high volumes[1].

Over the past 20 years, Company-A has established itself as a leading designer, manufacturer and marketer of computer control devices (mice and trackballs). In addition, Company-A is a worldwide leader in radio-based cordless input devices, offering a comprehensive selection of cordless keyboards, mice and gaming controllers. The Company also has become a leader in the PC video camera market. Moreover, Company-A has emerged as a leading provider of multimedia speaker systems and PC voice access products. More recently, the Company has become a pioneer in the area of digital writing, working with industry partners on solutions based on a Company-A digital pen that captures handwritten information in a digital form for easy transfer to the PC. Expanding into new markets, Company-A now produces interface devices for platforms such as gaming consoles and mobile phones. The Company produces controllers for the popular gaming consoles, as well as supporting features for specific games.

Company-A has long been at the forefront of technological innovation, with a list of more than 50 industry "firsts" to its name and a patent portfolio of more than 90 patents. In pointing devices, the Company led in optical sensing technology with the opto-mechanical mouse in 1982, and the first cordless optical mouse in 2001. The Company was also among the first to market a digital still camera in 1991.

Company-A demonstrated the first working USB prototype at the Fall Comdex in 1995. In addition, the Company pioneered digital radio-based cordless mice and keyboards and introduced the first Bluetooth-based peripheral, the Company-A Cordless Presenter™ designed for electronic presentations. In 2003, Company-A introduced another breakthrough product using Bluetooth technology, the diNovo™ Media Desktop™, which acts as a hub for connectivity between a desktop PC and Bluetooth devices.

[1] The company website

5.2.2.2 Industry overview

Main competitors[1]

Company-A's industry is intensely competitive. It is characterized by a trend of declining average selling prices in the OEM market, and continual performance enhancements and new features, as well as rapid adoption of technological and product advancements by competitors in the retail market. Also, aggressive pricing practices and downward pressure on margins has resulted in increased price competition from both our primary competitors as well as from less established brands.

Microsoft is the Company's main competitor in retail pointing devices and keyboards. Microsoft's offerings include a complete line of mice, trackballs and keyboards including cordless mice and desktops. Company-A is also experiencing competition and pricing pressure for corded and cordless mice and desktops from less established brands, in the lower price segments which could potentially impact its market share.

Company-A's main competitors in the U.S. for PC video cameras are Creative Labs and Veo. In Europe, its main competitors are Creative Labs and Philips. The Company is also experiencing ongoing competition from less-established brands in PC video cameras that are seeking shelf space and increased market share through price competition.

Competitors for Company-A's interactive entertainment products include Guillemot, Mad Catz, Pelican Accessories, and Saitek Industries. Company-A's controllers for PlayStation®2 are competing against Sony's sales of their own controllers. The Company also competes with another OEM manufacturer for sales of the EyeToy™ product to Sony. If Sony were to move away from Company-A as a supplier of this product, this could adversely affect the Company's OEM revenues. In addition, Company-A's controllers for Microsoft Xbox™ are competing against Microsoft's sales of their controllers.

Competitors in audio devices vary by product line. In the PC speaker business, competitors include Altec Lansing and Creative Labs. In the PC and console headset and microphone business, competitors include Altec Lansing and Plantronics. In addition, with the Company's

[1] Company-A annual report 2004

entry into the mobile phone headset business, it is competing against mobile phone and accessory companies such as Jabra, Motorola, Nokia, Plantronics and Sony- Ericsson, some of whom have substantially greater resources than Company-A has and each of whom have established market positions in this business. These markets are intensely competitive and market leadership changes frequently as a result of new products, designs and pricing.

5.2.2.3 Business strategy[1]

Company-A's objective is to strengthen its leadership in the growing market for personal interface products, linking people to the digital world wherever and whenever they need to access digital information to communicate, learn and play. The Company has historically served the installed base of PCs by offering innovative personal interface devices to address the needs of the desktop. While PCs are being used more and more as the digital hub to access information and communicate, other platforms such as game consoles and cell phones are also becoming a rich resource for people to access information, communicate and enjoy an expanding offering of interactive games. Company-A believes that the Company is well positioned to take advantage of the many opportunities in this growing marketplace.

In order to accomplish this objective, Company-A intends to pursue new areas for growth while continuing to protect and build on the Company's current strengths. This strategic direction focuses on personal interface products surrounding three digital environments: i) the Office Environment – Desktops; ii) the Living Room Environment – Game Consoles and Home Entertainment Systems; and iii) the Mobile Environment – Notebooks, Cell Phones, and Digital Writing.

5.2.2.4 Company financial review[2]

Company-A's Fiscal Year 2004 was a year of momentum. The Company exceeded its financial goals and achieved its sixth consecutive year of record revenue and profitability. As shown in Figure 5-1, the company posted revenues of $1.27 billion, representing 15 percent growth over the prior year. The net income was $132 million ($2.69 per share), see Figure 5-2. Operating income was $146 million, up 17 percent. Both its operating margin of 11.5 percent and net margin of 10.4 percent were record setting. It continued to generate strong cash flow from operations, which, at $166 million, set a new record for Company-A.

[1] Company-A Press Room
[2] Company-A financial review 2004

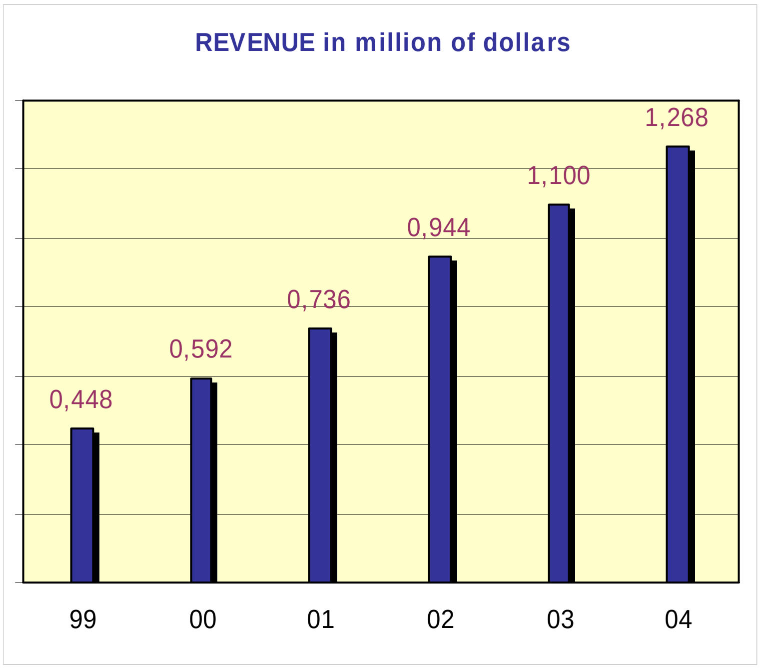

Figure 5-1: Company-A revenue from 1999 to 2004
(Adapted from: Company-A financial review 2004)

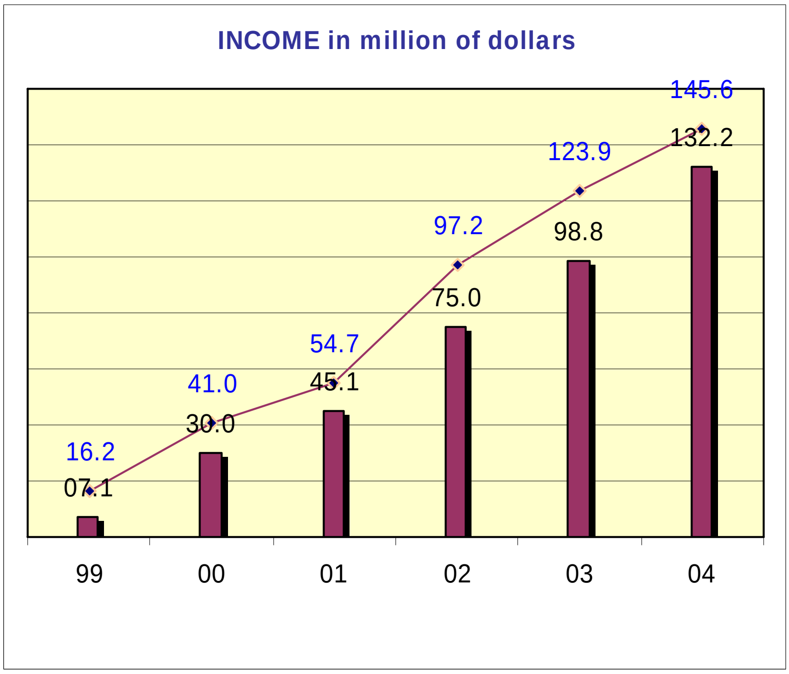

Figure 5-2: Company-A income from 1999 to 2004
(Adapted from: Company-A financial review 2004)

5.2.2.5 Market characteristics and the success factors for NPD at Company-A

The market for Company-A products is characterised by: i) rapidly changing technology; ii) evolving industry standards; iii) short product life cycles, and iv) frequent new production introductions.

As a result, Company-A must continually introduce new products and technologies and enhance existing products in order to remain competitive. The success of Company-A's products depends on several factors, including the ability to[1]:

i. Anticipate technology and market trends. Company-A achieve this by keeping a close relationship with its strategic partners and collaborator companies, who have deep knowledge of the technology and market in their field of business.
ii. Timely develop innovative new products and enhancements. The company achieve that by focusing on the NPD projects schedule. Any delay may result in losing the business.
iii. Distinguish its products from those of its competitors. Company-A insisting to have products with outstanding features and characteristics make it easier to use, more comfortable to the end user, and with up-to-date technology.
iv. Manufacture and deliver high-quality products in sufficient volumes. The product quality is a must for Company-A. The quality is the policy that Company-A follow to keep the customer loyalty. And;
v. Price products competitively. To keep a competitive price, the NPD project is executed in a way that it does not exceed the project cost plan.
vi. Maintain a good and close relationship with its strategic partners.

5.2.3 Company-A organisation structure and management

Company-A is organized into four business units – Control Devices, Video, Interactive Entertainment and Audio – which develop products and bring them to market. These business units are responsible for product design and development, industrial design, technological innovation and overall product management. Company-A's marketing and sales organization is responsible for selling the products brought to market by the business units, and is structured around two main sales channels, retail and original equipment manufacturers or OEM. The retail organization is responsible for sales to direct retail accounts, mass merchants

[1] Company-A annual reports (2003 & 2004)

and distributors while the OEM organization is responsible for sales to OEM customers. Company-A's sales and marketing activities are also organized into three geographic regions: Americas (including North and South America and Australia), Europe-Middle-East-Africa, and Asia Pacific. Figure 5-3, shows the corporate structure at Company-A, and Figure 5-6 shows the Company-A organisational structure.

Since 1994, Company-A has had its own manufacturing operations in Suzhou, China, which currently produces approximately half of the Company's products. The Company outsources the remaining production to contract manufacturers and original design manufacturers located in Asia, Hungary and Mexico. The Company's other operations support the business units and marketing and sales organizations through management of distribution centres and the product supply chain, and the provision of technical support, customer relations and other services.

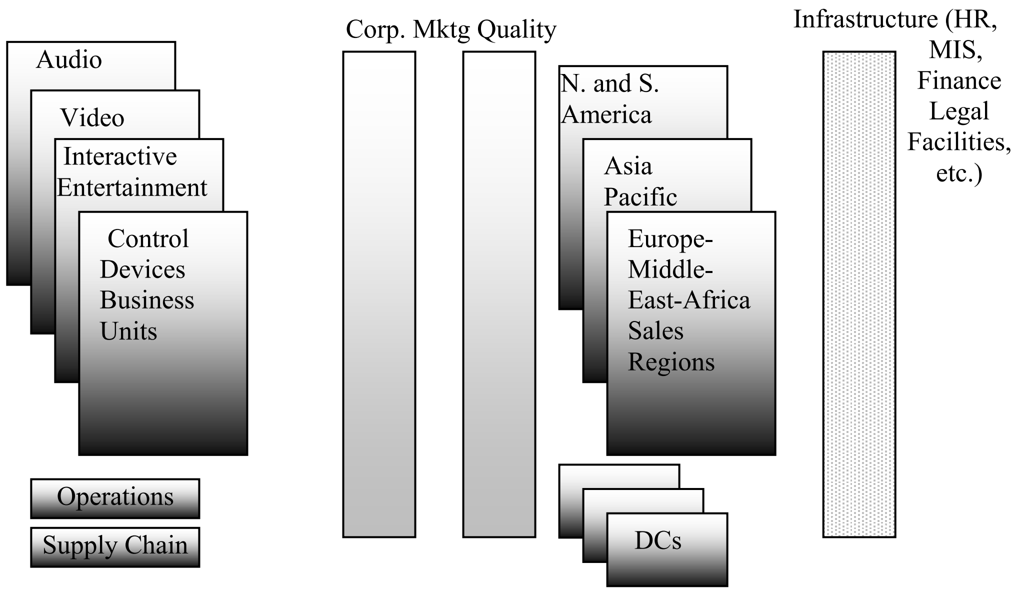

Figure 5-3: Corporate structure at Company-A
(Adapted from: Innovation leadership at Company-A case study[1])

5.2.3.1 Company-A board of directors[2]

The Board of Directors is elected by the shareholders and holds the ultimate decision-making authority of the Company, except for those matters reserved by law or by the Company's

[1] Prepared by Atul Pahwa under the supervision of Professor Jean-Philippe Deschamps, IMD, 2003.

[2] Company-A annual report 2004 and Company-A Press Room

Articles of Incorporation to its shareholders or for those that are delegated to the Executive Officers under the Organizational Regulations. The Board makes resolutions through a majority vote of the members present at the meetings. In the event of a tie, the vote of the Chairman decides.

At the first meeting following the Annual General Meeting of Shareholders, the Board of Directors appoints a Chairman and a Secretary. It is not mandatory that the Secretary be a member of the Board of Directors or a shareholder. Company-A’s Board of Directors is responsible for supervising the management of the business and affairs of the Company.

The Board of Directors has delegated the management of the Company to the Chief Executive Officer (CEO) and the Executive Officers, except where the law or the Company’s Articles of Incorporation or Organizational Regulations provide differently.

The Board of Directors has the responsibility for the supervision of the management of the Company. In particular, the Board of Directors has the following non-transferable powers and duties: i) Ultimately overseeing the CEO and other Executive Officers and issuing the necessary guidelines; setting strategic directions, the allocation of resources and Company policy; ii) Defining the organizational structure; iii) Overseeing the Company’s financial accounting, controls, planning and reporting; iv) Appointing and dismissing the CEO and other Executive Officers and assigning their signatory powers; and appointing and dismissing the head of the internal audit function; v) Reviewing the performance of the CEO and other Executive Officers and ensuring that the Company remains in compliance with applicable laws, the Articles of Incorporation, the Organizational Regulations and the guidance from the Board of Directors;

The Board of Directors also has the following responsibilities: i) The signatory power of its members; ii) The approval of the budget submitted by the Chief Executive Officer; iii) The approval of any type of investment or acquisition not included in the approved budgets; iv) The approval of any expenditure of more than US$10 million not specifically identified in the approved budgets.

5.2.3.2 Chief Executive Officer (CEO) of Company-A

The CEO manages the day-to-day operations of Company-A, with the support of the Executive Officers. The CEO has, in particular, the following powers and duties: i) Defining and implementing short and medium term strategies; ii) Preparing the budget, which must be approved by the Board of Directors; iii) Reviewing and certifying the Company's annual report; iv) Appointing, dismissing and promoting any employees of Company-A other than Executive Officers and the head of the internal audit function; v) Taking immediate measures to protect the interests of the Company where a breach of duty is suspected from Executive Officers until the Board has decided on the matter; vi) Carrying out Board resolutions; vii) Reporting regularly to the Chairman of the Board of Directors on the activities of the business; viii) Preparing supporting documents for resolutions that are to be passed by the Board of Directors; and ix) Deciding on issues brought to his attention by Executive Officers.

5.2.3.3 Business units, product units, and project management[1]

Business unit senior vice presidents, who also play the role of marketing directors for their respective businesses, report directly to the CEO. In some business units, such as Control Device, the largest business unit at Company-A, there is also a vice president of engineering. The business units are comprised of a number of product units. However, unlike business units, a single person did not head product unit. Management team consisting of an engineering head and a product-marketing head, working in partnership, ran the product unit jointly. As one manager explained: *"by forming these pairs, we made sure that we would remain a strong, engineering-driven company while not losing touch with the market. Business ownership is shared by both functions. At the end, they have to come to the business unit head and show a roadmap that is agreeable to both."*

This pairing of marketing and engineering is extended to the operating level. Product manager from marketing teamed up with project leader from engineering. Company-A traditionally managed the marketing and engineering sides of its project closely together and in parallel. As a consequence, product launch issues were not pushed towards the end of the development process, but handled from the very beginning concurrently with product design, development and engineering.

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[1] Innovation leadership at Company-A case study, prepared by Atul Pahwa under the supervision of Professor Jean-Philippe Deschamps, IMD, 2003.

5.2.3.4 Main organisational units at Company-A

Research and development

Company-A believes that continued investment in product research and development is critical to its success. The Company believes that its international structure provides advantages and synergies to its overall product development efforts. Company-A's product research and development activities are mainly carried out at engineering centres located in Fremont, California; Vancouver, Washington; Romanel-sur-Morges, Switzerland; Hsinchu, Taiwan; and Seefeld, Germany. Also, with the Company's recent acquisition of Intrigue Technologies, additional research and development activities will be carried out in Mississauga, Canada.

The location of the Company's Fremont, California facility allows Company-A access to Silicon Valley's talent pool, particularly important in the development of Internet applications, software and video technologies. Company-A's Swiss engineering centre provides the Company with advanced sensing and cordless technologies. In addition, the Swiss centre is a convenient point for gaining access to leading European technologies. Company-A has been successful in recruiting and retaining top engineering graduates from leading Swiss universities because it is one of the few personal computer technology companies with research and development activities in Switzerland. Through its Taiwanese subsidiary, the Company has established access to key Asian markets, engineering resources and high-tech manufacturing. Moreover, the common language of Taiwan and China facilitates the transfer of products from the Company's engineering launch site in Taiwan to its high-volume manufacturing site in China. Company-A's Vancouver, Washington engineering centre designs and develops the Company's audio products.

The Company's subsidiary, 3Dconnexion, whose research and development facility is located in Seefeld, Germany, provides Company-A with its ongoing research in 3D controller devices.

Company-A research and development expenses for fiscal years 2004, 2003, and 2002 amounted to \$61.3 million, \$56.2 million and \$50.5 million, see Figure 5-4. The Company expects to continue to devote significant resources to research and development to sustain its competitive position.

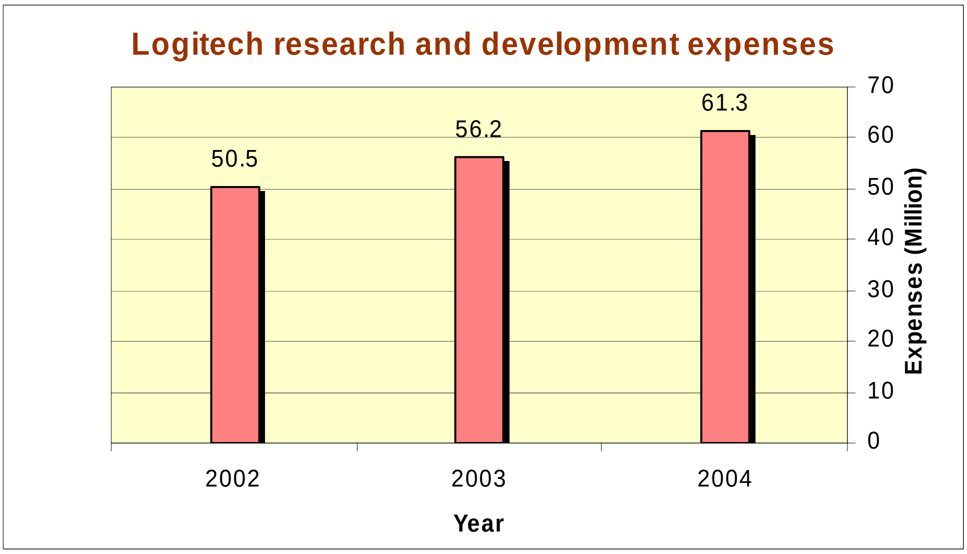

Figure 5-4: Company-A research and development expenses
(Adapted from: Company-A financial review 2004)

Marketing, sales and distribution

The primary end-user markets for Company-A mice, trackballs and keyboards have traditionally been consumers, small office and home office, or SoHo users and, through its OEM customers, corporate buyers. The primary end user market for Company-A entertainment devices, such as joysticks, gamepads and steering wheels, is consumers. The primary end-users for Company-A's audio products are consumers, SoHo, and OEM customers. The Company's end user markets for its PC video cameras are SoHo users, corporate buyers and consumers. Company-A's primary end user markets are in Europe, North America, and Asia-Pacific. However, it also markets its products in Latin America, the Middle East, Africa and other regions.

Company-A sells through many distribution channels, including distributors, OEMs and regional and national retail chains, including online retailers. The Company supports these retail channels with distribution centres located in the United States, Europe and Asia. These centres perform final configuration of products and product localization with local language manuals, packaging, software CDs and power plugs. In addition, Company-A's distribution mix includes electronic commerce in the U.S. as well as e-commerce capabilities in several European countries.

Customer service and technical support

Through its operating subsidiaries, the Company maintains customer service and technical support operations in the United States, Europe, Asia and Australia. Customer service and technical personnel provide support services to retail purchasers of products via telephone, email, facsimile and the Company-A website.

Manufacturing

The Company's manufacturing operations consist principally of final assembly and testing. Company-A's high volume manufacturing is located in Suzhou, China. The Suzhou facilities are designed to allow production growth as well as flexibility in responding to changing demands for the Company's products. Company-A is currently expanding its Suzhou operations with the construction of a new factory to provide for additional productive capacity to meet future demand. The new facility will initially have 30% greater capacity than the Company's existing operations as well as the potential to double beyond that.

New product launches, process engineering, commodities management, logistics, quality assurance, operations management and management of Company-A's original design manufacturers occur in Hsinchu, Taiwan, Suzhou, China and Hong Kong, China. Certain components are manufactured to the Company's specifications by vendors in Asia, the United States and Europe. Company-A also uses contract manufacturers to supplement internal capacity, to reduce volatility in production volumes and to reduce the transit time from final assembly to regional distribution centres. In addition, some products, including most keyboards, certain gaming devices and our audio products, are manufactured by third-party suppliers to the Company's specifications.

5.2.4 General NPD process model at Company-A

Company-A has implemented a simple but rigorous process to steer its product creation projects that typically lasts from six (for product extensions) to eighteen months (for totally new products). This process gives a lot of day-to-day freedom to the project teams, but it requires them to prepare for, and pass, three tough management reviews, or "toll gates," before commercial launch. These gates are passed in the course of animated meetings attended by the business and product unit heads, R&D director, as well as senior engineering and marketing mangers[1]. These people are known at Company-A as the NPD management committee. It's important to mention that in the past Company-A had a seven-gate process. This, however, has been changed as Company-A tried to simplify and speed up the development process. The three gates – gate 0, which is also known as the Strategic Front-End (SFE), Go gate, and gate 2 – are mechanical processes that Company-A management follows to get a certain output, in a certain time, within certain conditions. The NPD process model at Company-A is shown in Figure 5-5. However, it's important to note that it's up to the business units and product lines whether or not to follow the NPD process model.

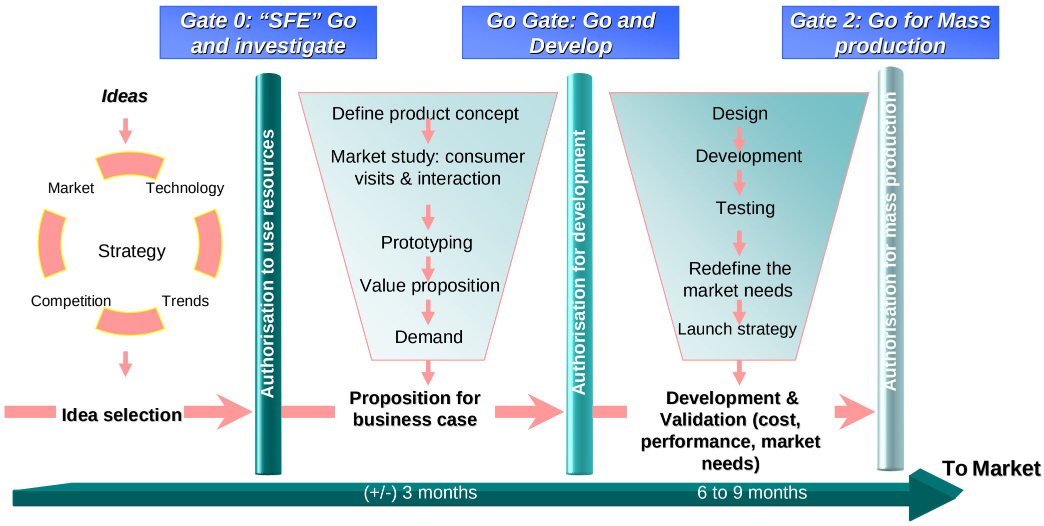

Figure 5-5: General NPD Process at Company-A

5.2.4.1 Idea generation

The company has always been open to examining both internal and external sources for new innovations. Despite having deep engineering-base roots, Company-A has learnt not to rely solely on its own technological resources. Even its engineers recognise that the important thing is not where the technology is sourced, but what can ultimately deliver the greatest value to customers. However, the NPD process at Company-A starts by generating ideas.

[1] Innovation leadership at Company-A, Case Study prepared by Atul Pahwa under the supervision of Prof Jean-Philippe Deschamps, IMD, 2003.

These ideas can come from different sources such as the product unit team, the engineering team and the marketing team. However, any member in the company could participate in this phase. The ideas are mainly influenced by the market needs, competition, trends and technology. The product unit team will select an idea for further investigation. As a matter of fact, most of the new product ideas came from the lower levels in the organisation. One of the business units directors said, "*We hire the best engineers and marketing people and give them all the freedom to do their job; they know better than us*."

5.2.4.2 Strategic front end (SFE)

Once an idea has been selected, the team asks to hold the SFE meeting, known as "Gate 0". The goal of this meeting is to receive the authorisation to invest resources to further investigate the idea. The participants in this meeting include the NPD team of the product unit, the product unit directors (engineering and marketing), the business unit director to which the product unit belongs, and the R&D director. The discussions involved at this level include whether the new product concept is interesting and promising enough, and whether the company should spend money on it. If the NPD management committee in this meeting feel that the idea is interesting and has a potential market, they give the order "Go and investigate" to invest the resources necessary for further idea investigation. This phase also includes formalising the project and advisory teams. There is always an average of three people (two engineering and one marketing), working full time for about three to six months, to prepare the proposal.

5.2.4.3 Preparing for/ and passing Go Gate

Go-Gate is the most important gate. For about three months, the NPD project team will try to define the product concept by visiting and interacting with consumers, receiving their input and figuring out their real needs, and developing the prototype to get alignments. In the end, the team has to convincingly articulate the full product concept to management, and present prototypes that validate its technical feasibility. The team has also to present the key elements of the business case, including market and sales volume estimates, detailed price and cost assumptions, the resulting margins after deduction of expected marketing and distribution costs, and the possible RoI Company-A will receive from the project. Finally, the team is expected to commit to broad project deliverables in terms of development cost, schedule and functionality. However, *a key "deliverable" is the product availability date (PAD) - the date when shipments to retailers can start*.

Each element of the plan is scrutinized, and not many proposals make it through the Go Gate on their first attempt. Management gets involved in the details, probing financial, operational and marketing aspects of the plan, and asks as many questions as they need to feel comfortable with the project[1]. If the business case is very well prepared and the NPD management committee is convinced, the NPD project team will receive an authorisation for developing the project.

From this point on, the project manger is responsible for the whole project. The project manager has a boundary of authority. If the project runs out of those boundaries (e.g. over cost, delay, or quality related issues), the project manager has to refer back to management.

5.2.4.4 Preparing for Gate 2

Once the project team receives this authorisation, the development team makes the design and develops an advanced prototype of the product (by creating a 3D prototype of the product). The team will also prepare all the sales materials, the announcements and advertising campaign, and the launching strategy. This is so that when they receive an order at “Gate 2” to go for mass production, everything related to marketing the product will be ready. The last step in this phase is the validation in terms of product performance and functionality. The goal of this is to check if the product actually reflects what was planned at the beginning of the project, and also to assure that there is still a need in the market for the product.

5.2.4.5 Mass production “Gate 2”

The last gate, Gate 2, is held just before mass production. All plans are once again carefully scrutinised before committing with suppliers and building millions of dollars of inventory. For totally new products, such as the io-Digital-Pen, a final market check is conducted prior to that decision point[2].

Every product Company-A develops goes directly to Taiwan for tool making and early pre-production activities (pilot manufacturing). Then the product moves to China where mass production is done. This means that Taiwan is a mandatory step in the project flow. No single

[1] Adapted from: Innovation leadership at Company-A Case Study prepared by Atul Pahwa under the supervision of Prof Jean-Philippe Deschamps, IMD, 2003

[2] Same reference

product goes directly to China. In the past, (over five years ago) mass production was done in Taiwan, which was expensive due to the high rate of the Taiwan labour wages (at least compared to China). The maximum quantity that can be manufactured currently in Taiwan is around 300 pieces.

5.2.4.6 Managing the NPD process at Company-A

Between these gates, the overall project responsibility lay in the hands of the project manager, which reflects a decentralised management style. Each week, project leaders for specific modules of the overall project would report on the status of their individual module to the project manager, and an entry into a Notes® database would ensure speedy project status updates within the rest of the organisation.

The program manager summarises the status of the team's progress through a system of green, yellow or red flags posted on the project tracking system. If, during the course of the project, a problem or delay occurs, a "yellow flag" would be raised, triggering notifications to all people involved. The project manager is still responsible for tackling the problem. But if it gets out of control, a "red flag" alerts senior management. The Business Unit head is the only person empowered to alter the project schedule and reset the product availability date[1].

For two years, however, Company-A has adopted an NPD project management model based on merging the engineering and marketing directors. Both directors manage the NPD life cycle (from idea to after-sales) of each product unit. In the proposal phase, both directors make many NPD proposals, which include the product strategy, product line management, resources needed, etc. Then, both together select the best proposal for presenting it to the NPD management committee for approval. R&D's main task is resource allocation in short, medium and long terms. The R&D director has to be sure that the NPD proposal is within the resources that are available for all the product units and in tune with the other NPD projects within the BU. After review by R&D, the proposal will go again to the product unit to re-work on the proposal within the available resources.

It is worth noting that once the NPD project has been accepted, *the project manager is able, to a large extent, to make decisions related to the NPD project*. At Company-A, it's widely

[1] Adapted from: Innovation leadership at Company-A Case Study prepared by Atul Pahwa under the supervision of Prof Jean-Philippe Deschamps, IMD, 2003

accepted by the top management that the project manager will take important decisions such as: the appointment of NPD project team members, what type or what brand of new equipment to be bought, the cost of the NPD project, operation priorities, training methods to be used for the NPD team member, which suppliers of materials and components are to be used, and the price of the output of the project. This all reflects the power the project manager has to manage his project.

On the other hand, the culture which is prominent at *Company-A gives the NPD team members the freedom and ability to make and execute the decisions that are critical to the operation or direction of their project*. The NPD team members at Company-A experience substantial freedom, independence, and discretion in their work. The team members are able to select different way to do their jobs and to make choices without being told by the manager to do so.

5.2.5 io-Digital-Pen project development

5.2.5.1 Introduction[1]

The 1990s saw the emergence of handheld computing with Apple's Newton™ and Palm's PDA (personal digital assistant). Pen computing emerged shortly thereafter with the advent of the IBM TransNote™ and the Sony Pen Tablet™. In 2001, Microsoft announced its Tablet PC™ initiative, promoting it as a new platform for notes organisation and management.

Anoto, a Swedish firm founded in 1999, had developed a digital pen and paper technology that attracted Company-A's interest. Slightly thicker than a ballpoint pen, the digital pen included a camera that captured one's writing on a specially designed paper and saved this as strokes in its memory. The paper featured a proprietary pattern of small dots that were not easily visible to the eye. This grid allowed the pen to recognise its absolute positioning with respect to a particular area of the page, and a particular page amongst several pages. The user could thus go back and forth from one page to another as with regular pen and paper.

Anoto's founding team came from the mobile telecommunications world and thus found it natural to work with Sony-Ericsson to develop the CHatPEn™. Launched in Q2 2002, it

[1] Adapted from: Getting the io™ digital pen to market, Case Study prepared by Atul Pahwa under the supervision of Prof Jean-Philippe Deschamps, IMD, 2003.

allowed users to write a message on Anoto digital paper and send it via a mobile phone. Company-A convinced Anoto of an even greater opportunity in the computing environment. In March 2002, the two companies announced an alliance, which was reinforced when Company-A made a 10% equity investment in Anoto. Company-A introduced an initiative that extended the power of the PC beyond the desktop. Subsequently, Company-A decided to manufacture a digital pen as well as develop software to connect the pen to the PC and several popular applications including Microsoft Office.

Concept description

With io-Digital-Pen, users can easily share, store, organise and retrieve their handwritten information by simply writing with ink on paper the way they have for thousands of years. An optical sensor embedded in the pen captures the handwritten images, storing up to 40 pages in memory. This captured digital information can then be transferred into the PC by synching the pen via a USB cradle. The Company-A io solution offers total mobility, since the only thing necessary to carry is the pen and a digital paper notebook[1].

The io-Digital-Pen uses technology developed by Anoto, a company whose pen-and-paper technology is emerging as a new standard for digital writing. The pen itself is the key component of an ecosystem that includes leading paper manufacturers- Mead Cambridge Notebooks from MeadWestvaco, Post-it® Notes from 3M and productivity tools from FranklinCovey® in the U.S., and the Groupe Hamelin in Europe – combined with Company-A's proprietary software. Suggested U.S. retail price for the complete system starter kit is $199.

"*Company-A is taking a very different approach to digital writing for the PC*", said David Henry, senior vice president and general manager of Company-A's Control Devices Business Unit. "*While other attempts at pen input have started with the PC, with the goal of making the PC more friendly, our point of departure is pen and paper, with the goal of making these elements more effective in the digital world.*" "*With io-Digital-Pen, there is no need to change the way you work, or to lug your PC to meetings*", Mr. Henry continued. "*We believe this product will be well received by today's mobile workforce, as well as consumers who are looking to be more effective and creative with their note taking.*"

[1] Company-A Press Room: Press Releases

The digital paper that enables the capture of handwritten notes contains patented pre-printed tiny dots, which form a light screen effect. This pattern is read by an optical sensor embedded in the pen, which then stores the information in non-volatile memory until the pen is docked in its USB cradle.

Upon docking the io-Digital-Pen, users can export their handwritten information to popular applications such as Microsoft®, Adobe® illustrator and calendaring tools including Microsoft® Outlook, Lotus Notes®, or any MAPI-supported email application. They can also create Post-it® Note reminders on their PC desktop. Note takers can also categorise and search their handwritten documents through the support of limited handwriting recognition by means of ICR (Intelligent Character Recognition) fields.

System requirements for the io-Digital-Pen include a PC running Windows® or higher, a 90 MHz or higher processor, 64 MB RAM (128 BM is recommended), Internet access, Microsoft® Internet Explorer 5.01 or later and Microsoft net framework, an available USB port, CD ROM drive and pre-printed paper. Email support requires a MAPI-compatible email client such as Lotus Notes® or Microsoft® Outlook®.

The io-Digital-Pen project in Company-A organisation context

After signing a licensing deal with Anoto, Company-A's management assigned the development of io-Digital-Pen and related software to the Retail Pointing Devices Unit (see Figure 5-6), which was one of four product lines within the Control Devices Business Unit, responsible for designing and developing a broad range of mice and trackballs. This product unit is responsible for designing and developing a broad range of mice and trackballs. The R&D director was also involved in the development process of the *io-Digital-Pen* project and is also the individual to whom the project manager reported. In this reporting system, there were four management layers separated between the *io-Digital-Pen* project leader and the R&D director.

As mentioned in section 5.2.3.3, unlike business units, a single person did not head a product line. A management team consisting of an engineering head and a product-marketing head, working in partnership, ran the product unit jointly. This pairing of marketing and engineering was extended to the operating level. A product manager from marketing teamed up with project leader from engineering. Company-A traditionally managed the marketing and engineering sides of its project closely together and in parallel. As a consequence, product launch issues were not pushed towards the end of the development process, but handled from the very beginning concurrently with product design, development and engineering.

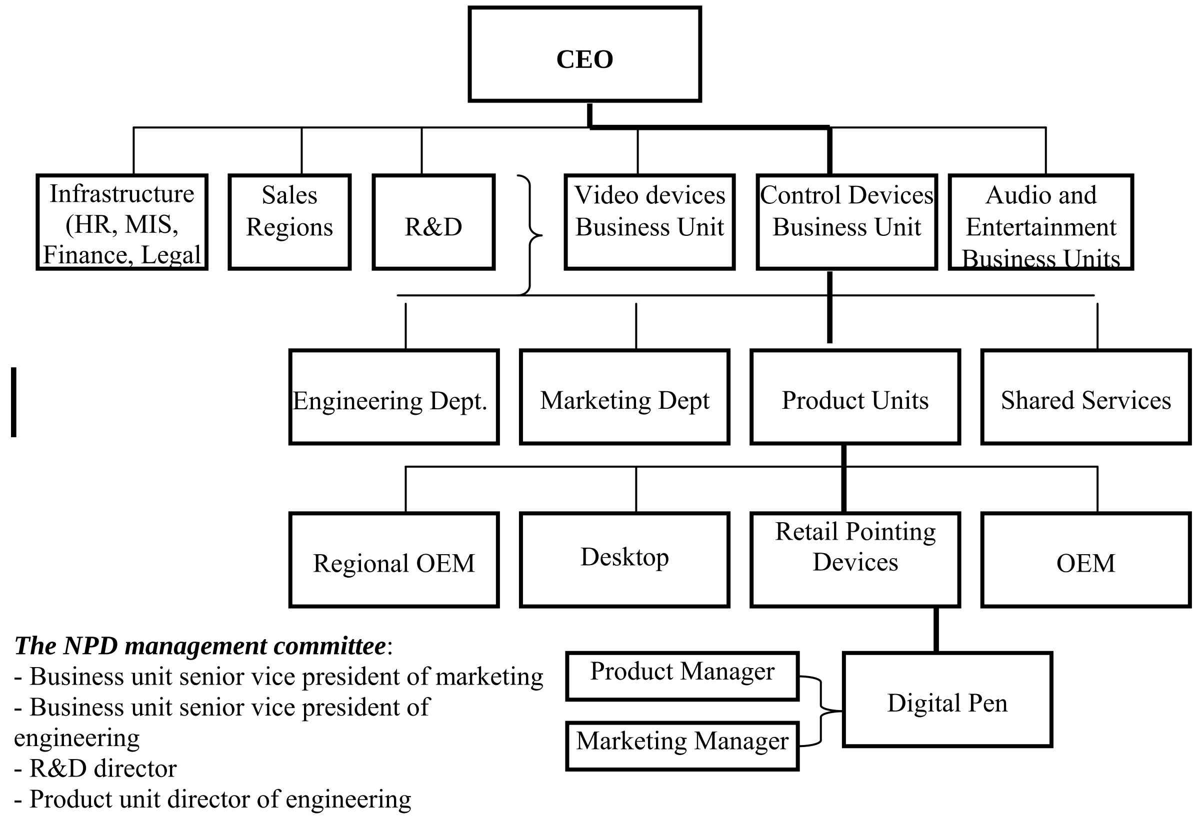

Figure 5-6: The digital pen project in Company-A context

In the io-Digital-Pen project, there were approximately 15-20 engineers – mainly electronics, communication, and software engineers – in addition to 5 marketing people working full time on the project. The project leader, who was an electrical engineer with ten years of experience working with Company-A, had the full responsibility of the project development. The top management became involved only when the project was not on plan (cost, schedule and performance, CSP).

Most of the important decisions in the *io-Digital-Pen* project were made by the project leader, sometimes jointly with his team: type of new equipment to be bought; the cost of the *io-*

Digital-Pen project; workflow priorities; and the price of the final product. All of this reflected the extent to which the project manager was empowered to manage the project.

The io-Digital-Pen project followed the typical NPD project management style adopted by Company-A, (see section 5.2.4). As for project control issues, the project had experienced some difficulties, and passed through the yellow and red flag procedures. This required the involvement of the top management to fix the problems and get the project back on track. However, during the execution of the project, the over cost problem was the main reason for raising the red flag. As is the case with most technical product development, the cost could not be estimated precisely. On the other hand, the CSP was underestimated. The project team stated that the CSP plan was based on data and information provided by the partners, which later appeared not to be very correct.

5.2.5.2 Actual development process of io-Digital-Pen project

Generally, the project followed the company's established product development process model. The development cycle time of io-Digital-Pen project took about 18 months (including ideas generation and selection). However, if we only consider the time from Gate 0 until the product availability date (PAD), then it was about 14 months in total. Although the engineering and marketing groups were working for months hand in hand on idea generation and selection to arrive at the SFE, the Go and investigate Gate was the official starting point of the development project. At this first and important decision point, which the io-Digital-Pen project passed in August 2001, the core project team had completed the following[1]:

i. Defined the product concept convincingly to top management;
ii. Validated the product technical feasibility;
iii. Committed to the broad project deliverables in terms of cost, schedule, and performance (CSP);
iv. Presented elements of a business case. The marketing group presented and defended the market and sales volume estimation, detailed price and cost assumptions, the resulting margins and expected marketing and distribution costs.

[1] Company-A: Getting the io™ digital pen to market, Case Study prepared by Atul Pahwa under the supervision of Prof Jean-Philippe Deschamps, IMD, 2003.

When the NPD management committee was satisfied with the project team proposal, it gave the engineering group authorisation to design and develop the concept.

From Gate 0 to Go Gate

Product concept:

Right from the start, and almost intuitively, the io-Digital-Pen was conceived as a branded product for the retail channel. An OEM launch would have required that buy-in from several partners and a significant time and resource commitment. In addition, the retail channel is more profitable for Company-A.

The pen could leverage Company-A's strong and growing brand franchise, good retail relationships and efficient distribution system. OEM, enterprise, or professional market segments were not excluded but considered only as additional business opportunities for a later stage. However, the detailed nature and size of those markets were not investigated.

Cost:

Since its early days as a supplier to the OEM market, Company-A had developed an obsession for targeting the lowest possible product costs. This allowed Company-A's products to be sold generally below $99, a psychological threshold for impulse purchases (95% of Company-A products retailed for $99 or less). However, it soon became clear that the digital pen, with its sophisticated technology (sensor/camera, memory and battery), could not fit with that pattern, a concept that management accepted.

The business case also included specific financial information, including contribution margins that reflected the CEO's obsession for costs.

Schedule:

The CSP package at the Go Gate traditionally required the team to specify a self-imposed product availability date (PAD). This was defined as the date when the product was expected to meet its specified quality targets and become available for shipment to the distribution channel. Anticipating the PAD – an analytical project scheduling exercise- meant putting together a detailed project path. At the Go Gate, the top management approved the PAD which proposed by development in September 2002.

Performance:

Industrial design and some software features were still not set, but the key performance attributes, from memory to battery life, were conceived and defined, and presented to and approved by management at the Go Gate. Service was a non-issue since the battery lasted the life of the pen. However, considerable attention would have to be given to technical and user/application support. The product that would be launched 16 months later ended up pretty much in line with that Go Gate concept in terms of its basic functionality and features.

Formalising the project and advisory teams:

In the Company-A tradition, the project team was composed of members from Europe (engineering), US (marketing), Taiwan (engineering and pilot manufacturing), and China (manufacturing). On the engineering side, the team was initially composed of senior members of the Retail Pointing Devices unit, but it also borrowed manpower resources from other units. Full-time personnel would be hired as sales developed, therefore justifying the additional overhead.

In parallel, the core product development team set up several task forces to handle specific challenges, particularly on software development and user documentation. As the project progressed, everyone realised that these areas would need more attention than originally anticipated.

Given the particularly risky nature of the project, Company-A set up an advisory team to steer and approve the work of the project development team. The advisory team consisted of three senior executives: the head of the Control Devices business unit, who had to initiate and closely monitor every aspect of the project; the product unit director, and the R&D director. They met in person every 8 to 12 weeks. Given the tight PAD deadlines and the difficulty of holding frequent meetings across different locations, the advisory team was forced to make on-the-spot decisions that eventually speeded up the launch process.

Refining the user concept after Go Gate:

The project team quickly realised that a number of product decisions, particularly concerning software, would condition important user applications. Such decisions would have to be taken in a vacuum unless that team had a better understanding of what customers would want to do with the pen. All involved in the project had been excited about the proposed product from their own perspectives, but they were concerned about introducing their personal biases into the decision making process. It was decided that the team develop a hypothetical persona through whom decisions could be channelled. In this way, they could imagine how the customer would react to alternative product features or applications.

Testing:

While Company-A routinely conducted extensive pre-launch tests of its traditional products (mice were extensively consumer-tested for design, colour and functionality), the testing of the io-Digital-Pen was limited. Basic usability testing was done on the product, which encompassed methods to identify how users interact with the product. In a typical approach, users use the product to perform tasks, while observers watch and take notes. Pen designs were tested online and the feedback was almost evenly split between a more conservative pen-oriented shape and a radical design. Company-A decided to go with the latter. Implicit in the choice of not having more detailed testing was the perception that testing totally new product concepts might prove misleading as customers lacked reference points.

Launch planning and preparation:

After the Go Gate, a number of launch strategy decisions were taken, particularly regarding the geographic scope of the launch, pricing strategy, channel strategy, signing up of stationery partners and sales targets. Before Gate 2, a number of critical launch issues were also handled, such as deciding on the product name, finalising the packaging, selecting the launch retailers, testing the product for usability, and pre-announcing the product.

Pre-announcement:

Creating a new product category requires educating the customer. Company-A decided to focus on industry opinion leaders to sell them the digital pen concept as a new, legitimate tool that filled a real user need (as opposed to being perceived as a new tech toy). Between February and March 2002, Company-A's CEO and Senior VP of Control Devices participated in several road shows with analysts, thought leaders and journalists. The objective was to ensure that the io-Digital-Pen "io™" would not be lumped, in the minds of these opinion leaders, with the slew of earlier products that had failed in that market. Company-A also wanted to differentiate the io™ from competing products by positioning it in a new "Personal Digital Pen and Paper" category. However, one of the key differentiating factors of the io™

pen was that it did not change the way people wrote notes, unlike Sony-Ericsson's Chatpen™ or Seiko's Inklink™.

CeBIT in Hanover, Germany (March 2002) provided a venue for the pre-announcement of the io™. To provide for a single worldwide announcement, a web-based conference call was set up for investors to learn details of the announcement. Communication objectives were clear: to convey the product positioning and its value proposition. It was also intended as a platform to generate industry-wide interest (including news, discussion forums and reviews) and secure on-going media coverage.

Authorisation to go for mass production "Gate 2"

Over the first half of 2002, the product was prepared for tooling and mass production, and packaging design and user documentation were done and translated. So, by July 2002, the io™ was ready to pass the Gate 2 milestone. This gate was perceived as a sanity check before spending huge amounts to buy components and commit firmly to suppliers. The io™ project passed that gate according to schedule and the September 2002 PAD was reconfirmed.

Compay-A's io™ launch

At project inception, it was decided that the product be released to the retail channel in September 2002. However, due to several delays in mechanical design, software and hardware, the team came out eight weeks late and the PAD had to be postponed to the third week of November 2002. By itself, that delay wouldn't have been critical, except it meant not getting the io™ to retailers in time for the crucial Christmas season in the US. That is why, in the US, the io™ was launched on the web before hitting the retail shelves. The actual public launch date in retail stores was set for January 2003.

5.2.5.3 The io-Digital-Pen project characteristics

This section presents the main characteristics of the io-Digital-Pen project: project development technical complexity and uncertainty; average number of activities to be executed each month; and average 'unit-time' needed to execute a development task.

The technological complexities of the io-Digital-Pen development activities were considerable, requiring multiple competencies to manufacture the product, from both the Company-A side and the project partners' side. As far as component parts and features were concerned, the product was based principally on new technological development from Anoto, one of the project partners. In addition, other technologies developed by other project partners (e.g., Agilent's optical navigation sensor and A4Vision's software algorithms) were integrated into the product to support the main technology. As is often the case with most technology intensive projects, the output of the development tasks was to a large extent unpredictable.

The development cycle time (DCT) of the project was approximately 14 months. The average number of activities that executed weekly in this project was relatively high (two to three tasks per week). Moreover, some development tasks were carried out in parallel. The average 'unit-time' to execute a task in the io-Digital-Pen project ranged from just a few days to weeks. These characteristics demonstrate why measuring the project development progress on a monthly basis would have been risky, considering, for instance, that it would have been difficult to fix a problem occurring at the beginning of the month.

5.2.6 Partners participation in the io™ development project

Company-A has rapidly and significantly expanded the number and types of product it develops and it will endeavour to further expand its product portfolio. This expansion places a significant strain on its management, and on its operations and engineering resources. With the growth of its product portfolio, Company-A experiences increased complexity in product development and manufacturing. As this complexity increases, it places a strain on its ability to accurately integrate its development activities with its strategic partners in order to meet anticipated customer demand and to develop effective marketing to stimulate demand and market acceptance.

In case the strategic partner is very important to Company-A's business, Company-A invests in that company, for instance by holding equities. Investment in other companies ranges from 10% (as the case with Anoto) to 49% (as the case with Fridy-Connection). Fridy-Connection is a German technology supplier company. In other cases, Company-A has loyalty basis agreements, or uses a combination of buying shares and establishing loyalty basis agreements. Company-A had equity investments in various technology companies totalling \$16.2 million. During fiscal years2004, 2003, 2002, and 2001 the Company made investments of \$15.2

million, \$.4 million and \$1.6 million, and sold or impaired investments amounting to \$.5 million, \$2.3 million and \$4.3 million[1].

Company-A partners range from very large to small-sized companies. Generally speaking, there is no specific organisational structure linking Company-A with its strategic partners. The relationship between the two sides is very flexible. However, in some cases, people from Company-A and its strategic partners work together to execute very technical activities. In these cases, specific contracts or structures are developed to link the development teams together for a certain period of time.

There are different reasons for Company-A to acquire or invest (by buying shares) in other companies. For instance, if the company of interest executes activities that meet Company-A's strategic plan, or if Company-A needs to secure the supply of specific components or technologies. In addition to these two reasons, Company-A may desire to minimise or avoid conflict that may evolve with partners because of its relationship with direct competitors. This is explained as follows: since Company-A's partners are among the best in class in their industries, they have the required discipline and expertise to develop outstanding work. This can be an advantage that Company-A values, but it has disadvantages as well. There will be many competitors; some are direct competitors, who would like to work with the same supplier. Company-A's supplier would like to increase his market share by selling the same technology to Company-A's competitors. Once the partner improves his technology or components to meet Company-A's requirements, he can supply the same technology or components to the competitors as well. This relationship of the partners with the competitors of Company-A is the main source of conflict that has evolved between Company-A and its partners. This may explain why Company-A sometimes acquires and invests in the partners.

However, Company-A is more interested in high-tech start-ups that fit its business. The company believes that partnering with, and investing in start-ups will result in outstanding business performance. Company-A has recently acquired small companies such as harmony (a company of 80 people based in Canada and experts in remote control,), QuickCam, Labtec and Intrigue Technologies.

[1] Company-A annual report 2004

Company-A is a big customer for most of its strategic partners. The company maintains a close relationship with its partners and these partners participate on regular basis in developing the road map of Company-A products. This close relationship enables the partners to be prepared for the next product that Company-A is going to develop.

In general, Company-A will not accept standard components or products from its partners. In most cases, Company-A demands a very precise technical specification from its strategic partners. In order for Company-A to receive the right product from its partners, people from Company-A and the partners may have to work closely together to customise the product to meet market requirements and technical constraints.

In addition, Company-A frequently asks its strategic partners for an exclusive licence to develop a very specific technical component. The partner is then unable to develop or sell the same units to any other companies. In such exclusivity licences, Company-A invests and/or shares resources required to develop the requested component. These resources include money, knowledge, IT, intellectual property (IP) and people (e.g. engineers). The engineering team works closely with the partner, and may even move into the partner's location in order to have optimum interaction with the supplier's team and to insure that the unit meets Company-A's requirements.

There are some selection criteria that Company-A uses to identify possible strategic partners. Company-A looks always for the leader in an industry. The industry leader has the capability to progress and to further develop his technology. It is not enough to select a partner who is the best in the industry today; Company-A tries to ensure that this supplier will keep, if not improve his position and be the best in the coming years too. In addition, the continued viability and financial stability of the partners and the adequate capacity to fulfil the needs of Company-A are among the important criteria in selecting strategic partners.

However, managing the complex relationship with strategic partners is not an easy task. One of the NPD project directors at Company-A stated that: "*If Company-A is unable to integrate its product development process with its partners, the consequences could include delay in product launch, over cost of development project, and a low quality product that may not meet the customer expectation. These serious issues may in turn affect badly entire Company-*

A business (e.g. frustrate its customers, degrade the levels of customer support, and lose business."

In the io-Digital-Pen project, the project manager and his development team participated actively in selecting the project partners. As stated before, most, if not all of Company-A products are developed in partnership with other companies. In the io-Digital-Pen project, 60% of the project partners were well-known to Company-A before (having worked jointly on previous NPD projects), while 40% were new to the company (partnering with Company-A only for io-Digital-Pen project, as the case with Anoto). These partners were completely selected by the project manager and his development team. However, the top management was involved in two cases – when the partner might impact the business and/or the long term strategy of Company-A, as in the case of the Design-Partner Company who designed the external shape of io™.

Project partners were classified into two categories. The first included the original design manufacturers (ODM), contract manufacturers; who produced key portions of io™ product line, and the key components suppliers. The second category was the technology suppliers. In the next sections, io-Digital-Pen project's main strategic partners are introduced. A general description of the partners' business is given, focusing on the partner's added value to the Company-A development process.

5.2.6.1 Component and product portion suppliers

Agilent[1] (component supplier; Sensor)

Agilent Technologies is a global diversified technology company that provides enabling solutions to markets within the communications, electronics, life sciences and chemical analysis industries. The Company has four primary businesses: Test and Measurement, Life Sciences and Chemical Analysis, Semiconductor Products, and Automated Test Equipment. The Company has approximately 28,000 employees and serves customers in more than 110 countries. About two-thirds of Agilent's revenue was generated from outside of the United States in fiscal 2004.

[1] http://we.home.agilent.com

Agilent optical mouse sensor solutions

Agilent pioneered position sensing for mouse technology and supplies these products to all major optical mouse manufacturers worldwide, having shipped more than 300 million sensors to date. Agilent provides a broad portfolio of mouse sensors, ranging from inexpensive, entry-level LED-based models to high-precision versions. Since their introduction, optical mice powered by Agilent's optical sensing technology have established themselves as the standard in computer input devices. Agilent's new laser mouse technology is expected to revolutionize the mouse industry yet again.

Agilent and Company-A[1]: Agilent is the manufacturer and supplier of the optical navigation sensor that Company-A uses in its optical mice, and manufactures and supplies CMOS image sensors used in Company-A's popular PC camera products.

Company-A had a joint R&D agreement with Agilent. Both, created a proprietary optical chip that features a three-month battery life and 800 dots-per-inch (DPI) resolution- twice the resolution of existing optical navigation sensors - for greater accuracy on any surface. Agilent also supplies CMOS image sensors used in Company-A's line of QuickCam web cameras and ClickSmart dual-mode digital cameras. These cameras enable photo and video e-mail, stop-frame animation and even instant messaging with live video. Company-A use Agilent' image sensors technology in the io project, as well.

Cypress Semiconductor Corp2 (component and chips maker; wireless USB)

Cypress Semiconductor Corporation is based in California, USA. Cypress solutions are at the heart of any system that is built to perform: consumer, computation, data communications, automotive, industrial, and solar power. Cypress's product portfolio includes a broad selection of wired and wireless USB devices, CMOS image sensors, timing solutions, network search engines, specialty memories, high-bandwidth synchronous and micropower memory products, optical solutions, and reconfigurable mixed-signal arrays.

[1] Company-A Press Room: Press Releases
[2] http://www.cypress.com

Cypress and Company-A[1]

Company-A is using the Cypress Wireless USB® radio system-on-a-chip for the Company-A® Cordless 2.4 GHz Presenter, the new wireless presentation controller with a built-in programmable timer. Wireless USB, which is based on a patent-pending, frequency-agile, Direct Sequence Spread Spectrum (DSSS) data transmission technique, offers a unique combination of robust performance, low power, low latency and immunity to interference from sources such as cordless phones and WiFi devices. With a transmission range of up to 10 meters, it can be deployed as a point-to-point or multipoint-to-point solution. Operating in the 2.4 GHz global ISM band, Wireless USB technology allows Company-A to deploy their solutions worldwide, regardless of regional frequency requirements. Wireless USB technology provides designers of io project with a highly flexible architecture that decreases development time, component count and overall system costs.

Design Partners

Design Partners, an Irish company, was founded in 1984. Design Partners are experts in creating products for international brands. The company works with clients to energise each brand, often to revolutionise the market. As designers, Design Partners push the boundaries of each product. The company believes that even the most complex technology can be translated into a simple design solution. One that balances form and function and that people love to use. The Design Partners' clients are companies who know that design is a brand necessity, and who believe that excellent products build strong, differentiated brands. The Design Partners plan the client project with him from the start, on defining the design brief.

Design Partners and Company-A[2]

The Design Partners have been starting partnership with Company-A since 1996. Company-A had equity investment in Design Partners. The company design the shape of the commercial product of Company-A based on market requirement and engineering and technical constrains. Traditionally, Design Partners provide Company-A with all the design for the Game controllers. One of the recent projects that Design Partners worked on is the io-Digital-Pen product. The io-Digital-Pen is first of a new generation of pens, which enables users to

[1] Company-A Press Room: Press Releases
[2] Company-A Press Room: Press Releases

download hand-written notes directly to a docking station. The io-Digital-Pen project will be described in length later in this case.

5.2.6.2 Technology suppliers

***Anoto*[1]**

Anoto Group AB (former C Technologies) is a Swedish high-tech company with 100 employees in total. The company has been created in 1999. It has unique solutions for transmission of handwritten text from paper to digital media and scanning of printed text. All products are based on digital camera technology and image processing in real time. The Anoto Group today has two brand names: Anoto® – a comprehensive solution entailing paper, pen and server technologies, allowing us to connect all types of writing paper with the digital world and C-Pen® – a scanning pen that can store, interpret and transfer printed text.

Anoto functionality brings together digital communication and handwriting, putting the power of digital communication into pen and paper. It involves digital pen technology, digital paper technology and server technology.

Anoto and Company-A

In 2003, Company-A launched the digital pen enabling Anoto functionality, Company-A io™. It is a digital pen for the PC platform and handwritten digital information can then be transferred into the PC by synching the pen via a USB cradle. Upon docking the Company-A io™ pen, users can export their handwritten information to popular applications such as Microsoft® Word etc.

Company-A made a $15 million cash investment in the Anoto Group AB ("Anoto"), which represents approximately 10% of Anoto's outstanding shares. In connection with this investment, a Company-A executive was elected to the Anoto board of directors. Anoto is a publicly traded Swedish high technology company from which Company-A licenses digital pen technology[2].

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[1] http://www.anoto.com

[2] Adapted from: Annual report pursuant to section 13 or 15(d) of the securities exchange act of 1934, United States securities and exchange commission, Washington, D.C. 20549.

A4 Vision

A4Vision (Applications for Vision) develops and licenses advanced identification systems and solutions for tracking and targeting camera systems and breakthrough 3D face recognition technology. A4Vision products are designed for broad security applications such as surveillance and access control, law enforcement and commercial markets such as PC and Internet applications. A4Vision's 3D facial biometric and camera tracking systems are based on a combination of patented optical technology, targeting and tracking software, and recognition algorithms. Through innovations in the 3D data capturing and processing capabilities, these systems permit industry-leading accuracy in real-time facial recognition and tracking. A4Vision is headquartered in California (USA) with offices in Geneva (Switzerland) and Moscow (Russia).

A4Vision and Company-A

A4Vision's breakthrough software algorithms enable Company-A webcams to target and automatically track a person's face, keeping it centred within the camera's field of view. More precisely, this Face Tracking technology, tracks a combination of skin tones, shapes and movement to lock onto a person's face. This new feature takes digital zoom to the next level by automatically enabling the camera to pan, tilt and zoom-in on a person's face – keeping it centred during a video instant messaging session or when recording a video email. The same technology is used in io project to capture the hand-writing and convert into characters.

Company-A made cash investments in A4Vision, Inc. ("A4Vision") totalling $.8 million, which represents approximately 12% of A4Vision's outstanding shares. In connection with this investment, a Company-A executive was appointed to the A4Vision board of directors. A4Vision is a privately held company from which Company-A licenses face tracking software[1].

3M[2]

3M is a diversified technology company with a worldwide presence in the following markets: consumer and office; display and graphics; electro and communications; health care;

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[1] Adapted from: Annual report pursuant to section 13 or 15(d) of the securities exchange act of 1934, United States securities and exchange commission, Washington, D.C. 20549.
[2] http://www.3m.com

industrial; safety, security and protection services; and transportation. 3M was founded in 1902 in Minnesota. 3M is a global enterprise characterized by substantial intercompany cooperation in research, manufacturing and marketing of products. Currently, the company's world sales are about $20.011 billion, with more than 67,000 employees. Recognizing that there are many applications for 3M technologies that have remained untapped, 3M is offering some of these unique technologies for license, so other high-tech companies can also benefit from these valuable assets. One of the technologies that developed by 3M is the Post-it® Software Notes – Professional. The pen input on the Tablet PC lets the user to take notes in his own handwriting wherever he is. Perfect for recording action items at meetings, taking notes on the go or just personalizing your messages.

3M and Company-A

3M's Post-it® brand is playing a key role in the evolution of writing instruments. Post-it® Notes for Digital Pens are just like regular Post-it® Notes, except they are preprinted with a faintly visible dot pattern. These notes are used with digital pen that recently debuted as the latest way to communicate electronically. The pen looks much like a typical ballpoint pen, only thicker in diameter. A camera and processor inside the pen let the user create handwritten electronic messages by simply picking up a pen and scribbling a note. 3M provides Company-A with pocketbook of Post-it Notes and Post-it Software Notes (Lite) for the io-Digital-Pen.

Some of io-Digital-Pen project's strategic partners are shown in Table 5-2. It is worthy noting that in this case study I only focus on the relationship between Company-A and its project strategic partners in whom Company-A had equity investments: Anoto, Design-Partner, and A4Vision.

5.2.6.3 Conflict between io-Digital-Pen project team and their partners

As in any other project, it happened during the execution of the io-Digital-Pen project that, from time to time, conflicts came up between the development team within Company-A and between the development team of Company-A and the project partner's teams.

Within Company-A

Company-A encourages open and informal discussion, and free exchange of opinions. This could be a source of conflict between different people involved in the project. Company-A has no clear rules or procedures to solve conflicts between people. Although the company has developed a manual for responsibilities and decision making (who decides what), it was not compulsory for the people of Company-A to follow. Solving such conflicts may require the involvement of the top management.

Table 5-2: Io-Digital-Pen project strategic partners

Partner name and type	Type of relationship	Expertise	Size (people)	Component/ Technology to io project
Anoto (technology)	Equity-based partnership (minority holding)	digital media and scanning of printed text	Small (100)	Digital camera technology and image processing
Agilent (Component)	Joint R&D agreements	Communication and electronics	Large (28,000)	Optical navigation sensor
Cypress Semiconductor Corp (component)	Contractual agreements	Component and chips maker	Large	Wireless USB and image sensors
Design Partners (design)	Equity-based partnership (minority holding)	Shape design	small-to medium	Final product shape
A4Vision (technology)	Equity-based partnership (minority holding)	Identification systems and face recognition	------	Software algorithms to target and track hand writing
3M (technology)	Contractual agreements	Electro and communication	Large (67,000)	Post-it ® Software Notes

Unlike the case in other companies, in Company-A there were no conflicts between the marketing and engineering people. People from marketing did not misinterpret the information from product design and never expected more functionality than could be provided. This is because the marketing and engineering teams worked hand-in-hand from the early phase of the project.

With the External Partners

Conflict with external partners differs from within company conflict, as it could have very serious consequences, not only on the project, but on the entire business as well. Both sides, Company-A and the partners, have to balance their overall business needs and the project need. Both sides have to take the business dimension in consideration. Sometimes Company-A has to accept some things it would prefer not to, in order to obtain some things that might be more valuable for the company. It has to be a win-win situation. Company-A cannot win all the time at the partner's expense.

During the execution of the io project, the project team faced two serious conflicts. The first occurred during the design phase, with the Design Partners - a strategic partner for Company-A business, not only for the io project. The second was with Anoto - the technology supplier of the digital pen product. The two conflicts were due to unplanned and newly raised issues. Both cases showed that there was a lack of formal procedure to handle such problems. The project manager solved these types of conflicts based on his experience and on what he thought to be the right thing to do.

During the two conflicts, the project leaders from both sides met and arranged a meeting between teams of both sides. In other words, all the meetings to solve conflicts between Company-A and its partners were arranged, hosted, and facilitated by the project leaders. It was the managers' responsibility to ensure that both sides knew exactly what points they were going to discuss, and what issues they were going to resolve. The conflict solving was based on negotiation on two levels, the project leaders' level and the project teams' level. However, it was seen that it should not be the role of the Company-A project leaders to be a bottleneck for communication between project members of both sides. The leaders arranged, facilitated, and organised the meeting, then the project members met to have the work done.

It's important to note the following two points. First, the number of conflicts during the io project (two conflicts) was very small in comparison to other projects conducted with partners. This is due to the fact that there was a high level of communication between the project team of Company-A and their partners. These conflicts were resolved while they were small. This is because of the decentralisation of the management system at Company-A, which allows the project managers to take the necessary decisions and actions to solve problems fast, without causing delays by waiting for the top management to be involved. This also indicates the power of the project manager in leading his project.

5.2.7 Integration process elements with the strategic partners during io™ project

In this section, I investigate the average intensity of communication and coordination between the io-Digital-Pen project team of Company-A and the project strategic partners' teams, specifically, those in whom Company-A had equity investment (minority holdings): Anoto, Design Partner, and A4Vision.

According to the io project team of Company-A, working and integrating the development process with the project strategic partners is not optional. This belief led the io project team to communicate and coordinate with the project partners without being told to do so. The project team perceived working together with partners to be highly important and acted accordingly for three main reasons:

i. The io project team could not carry out their tasks properly without communicating or coordinating with the strategic partners;
ii. The io project team acquired new knowledge and skills, and this can be obtained through communication and coordination activities with the project partners;
iii. Communication and coordination were needed to correctly interpret information from other partners and overlapping the development activities.

5.2.7.1 Communication with the io™ project partners

In this section, the two elements of communication which were identified in Chapter 4 are presented. These two elements are: frequency of communication between the io project team of Company-A and their project strategic partners; and the flow of information between them. These elements will not be described independently because they are frequently found to be interrelated.

Frequency of communication and flow of information across project partners were different from phase to phase, based on the need of each single phase. They also took different aspects ranging from face-to-face meetings, conference calls, video teleconferencing, and email exchange, to sharing database systems. In the io project, there was a very intensive communication between the partners - both technology and component suppliers - during concept identification and design phases. Following is a full explanation of this.

The io project team knew very well that they could not design a part or component of the product if it was not the core of their speciality. In addition, since they were not experts in the supplier's field of industry, it was impossible to make a clear request for a technical component or part necessary for the development of the digital pen product. The project team presented to the partners the concept of the new product and what was needed to develop the product. The combination of frequent interaction with the supplier and the ability to have their own point of view led the team to come up with the right component in the end. The idea was to benefit from the supplier's expertise in his own field. There were no predefined models or decision processes to allow the partners to participate. It was closer to what development teams at Company-A called it “consulting” the suppliers from the very early stage of the development project until the end. Indeed, this interactive way of working was important to the development of the io business case presented in the beginning of the project to the NPD project committee for approval. The io project team would have been unable to estimate the time and cost of development, or the quality of the product without the full engagement of the partners in developing the business case.

As stated before, Company-A does not accept standard components or products from its partners. The company demands a very precise technical specification from its strategic partners. This was the case in the io project. In order for the development team to obtain the right product from their partners, engineers from both sides had to work closely together to customise the product to meet market requirements and technical constraints. Basically, there were no formal procedures for working with the partners. However, there were, in some cases, specific contracts or structures linking the development team of both sides together for a certain period of time. An example of unstructured relationship can be found in the design of the digital pen.

To design the external shape of the io-Digital-Pen, the product development had to work closely with Design-Partner (an Irish company Company-A had been working closely with since 1996). On the other hand, for the identification system of the digital pen, the product development team had to work with the A4Vision. The three companies made up a team aimed at designing the product shape based on marketing requirements and engineering constraints. To do so, the team had face-to-face meetings on a monthly basis, in addition to conference calls and email exchanges.

However, working with the partners was not as easy as the development team thought it would be in the beginning. Since the very beginning of the project, there was bilateral work that had to be done between Company-A and the technology supplier, Anoto. The two companies started working on this project with no prior experience in working with each other. The io project manager said: “*It’s exactly as if you wanted to get to know your new girlfriend*.” The people from the two companies spent some time just to get to know each other, to understand what every part meant when specific terminology or expressions were used, such as process, qualification, verification, testing, etc. The goal of the project manager was, in that phase of the project, to develop a common language with the Anoto team. The two partners developed a common lexicon, a list of words with definitions. This proved very useful, especially in the beginning of the project. It helped to limit the sources of misunderstanding between them. This lexicon had a positive impact, which was noticed by the entire io team, on the weekly communication through video conferences, which was the minimum level of communication between the two sides. However, in addition to video conference meetings, there were face-to-face meetings held either in Sweden or Switzerland, for design review and technology development. These meetings took place every two months in the beginning of the project and during the design phase.

In addition to these means of communication, Company-A has adopted information technology and systems to improve the level of communication with Anoto, A4Vision, and Design Partners. Lotus-notes database and groupware are key tools for all Company-A development projects. These information systems enable teams from different partners to communicate with each other, share documents, and generate custom workflow applications. The teams may all be connected to the same local area network, or may be connected via modem or remote access bridges. Information is generally stored on a scaleable Notes server in the form of an encrypted relational database, in which various types of data can be stored. Users can create their own forms, providing a customized view of the data. Fax, voice mail, and pager gateways enhance the portability of the data. Also, Company-A and its strategic partners use Microsoft Project to manage the project. It may be interesting to note that the development team of Company-A also uses some chat rooms to communicate on-line with the partners (such as Yahoo, and hotmail MSN messenger).

For securing the exchange of documents and files with its partners, Company-A uses FTP (file transfer protocol). Also, a revision control system is used to enable tracking the files exchanged between teams. In fact, Company-A extensively uses IT as a mean of communication to overcome the wide geographical distances separating Company-A and its strategic partners. In selecting the strategic partners, Company-A selects the best in class, and does not want to be limited by where the partner is based.

This high frequency of communication and information flow between the io project team of Company-A and the project strategic partners has enabled the following: i) the project purpose, targets, and plan were well understood by entire teams participating in the project; ii) the information related to the project flowed freely among the teams, and iii) all channels of communication were open. This resulted in speeding up the decision making process; up-steam and downstream partners know about each other’s functions and capabilities, and last, but not least, there was less conflict between project partners.

5.2.7.2 Coordination with the Io-Digital-Pen project partners

During the R&D phase of the io project, some suppliers, such as Design-Partner and Anoto, suggested making some changes in the design and function in order to reduce the cost, improve some aspect of the product, and reduce the complexity of manufacturing. The project manager and his team were convinced that the earlier they coordinated with project partners, the better the project performance would be. Otherwise, the project would have faced problems later on, wasting time, money, and effort. Consulting the project partners right from the beginning of the project avoided re-work and introduced overlap of activities during the execution of the project.

As there were many partners participating heavily on the io project, Company-A developed clear specifications, definition of the deliverables, roles and responsibilities, who does what in the project, and work break down structure, all aimed at coordinating the activities execution between partners. Some of those arrangements were already mentioned in the contract between Company-A and its partners; others were developed by the project leader, and reflected the project management culture at Company-A. The project team could not establish a project schedule before establishing the deliverables and the responsibility matrix for those deliverables. For instance, there was a project time line, showing clearly what Company-A had to do, what Anoto had to do, and the interdependency between the two. This also existed with the other partners. In this way, if a partner had a delay executing one activity, it would be clear which other activities were going to be affected by that delay.

During the execution phase, the io project team shared tangible and intangible resources wherever needed. First of all, the database and project management system were shared with the A4Vision, Design Partners, and Anoto. This way, all strategic partners participating in the project were informed, on a daily basis, about the project’s progress. All project partners were able to prepare their part of the work on time. In case there was a delay or any sudden change in the project plan, the project partners were informed so that they could immediately adapt to the new plan. In some cases, people from the partners worked with the io project team on their site for couple of days. This allowed the io team to benefit from the knowledge and experience of their partners. This approach to the work enabled the io project team and their partners to work smoothly and cohesively to develop the digital pen project. This resulted in a smooth transition of output from one partner to become the input for Company-A and verse-versa, and minimised the amount of re-work.

However, due to the fact that there were many activities to be executed on weekly basis, and due to high number of partners participating in the project, the io project manager and team spent a high percentage of their time and efforts on coordinating the activities within the company and with the project partners, taking in consideration the fact that there was no formal process or standard procedure to coordinate activities with the project partners.

5.2.8 Io-Digital-Pen project performance

5.2.8.1 R&D performance

The development projects at Company-A, in general, are considered successful if the projects meet the cost, schedule, and performance (CSP) planned for the project, as is true for most development projects. However, because development cost is amortized over high volume for most devices, Company-A is less sensitive to this variable than it is to product cost. Anything less than 20% over the planed development cost is not considered a big issue, specially for new-to-firm project, like io-Digital-Pen, while more than 5% over the product cost is thought to be considerable.

In the io project, the development team were not able to meet the schedule and the cost targets. So the project had a delay of up to six weeks, which meant 10 % delay (The planned development time was 14 months), and was over cost by about 14 % of the planned cost. Both figures were considered small and within the accepted range of successful NPD projects. However, the reasons behind the delay and over cost originated in different phases. In fact, Company-A is less sensitive to 'development cost' than it is to 'product cost.' Anything less than 20% over the planed development cost is not considered a big issue, especially for new-to-firm project, like io-Digital-Pen, while more than 5% over the product cost is thought to be considerable.

One of the main reasons for the delay and over cost in this project was due to the inaccurate information provided by one of the technology supplier. The supplier provided the development cost estimation in the early phase of the project. As this supplier was the source of this technology, the io project team of Company-A had no other information available to estimate the cost but had to trust this supplier, which turned out to be a poor decision.

The second delay occurred during the beginning of the production phase. Specifically, there was a huge problem with the silicon supplier, related to the quality of the material they provided. This resulted in stopping the production and waiting for improvement of the specification. The silicon supplier was not considered a strategic partner for Company-A. Indeed, there were many suppliers for silicon material, and it just happened that during the io project that one was the main supplier for silicon material.
It is worth noting that the two main reasons behind the delay and over cost of the project had nothing to do with the communication and coordination processes conducted by Company-A with these partners. In other words, during the project execution there were no delays due to repetitive work, difficulty in output and input transitions, slowness in decision making, etc.

5.2.8.2 Marketing performance[1]

Since the io-Digital-Pen was a new product category, much of the quantitative aspects of the io^{TM} business plan were hypothetical. Given the lack of industry and market data, the goal was to sell 100,000 pens in the first year. Target sales figures were based on an assumed sales volume per month per store. For example, the only initial metrics discussed were a target of two pens per retail store per month and reaching a certain percentage of the customer base in Franklin Covey stores. The German forecast was established as a percentage of the expected US volume. There were no defined metrics for e-commerce sales.

However, senior management strongly believed in the long-term potential of the io^{TM} and the CEO explicitly stated that the team should not worry about first-year sales or profitability. The goal was to get the product out in the market and by the second year build a strong base of repeat customers. Company-A had high hopes for sales of about $100 million for the coming years.

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[1] Adapted from: Company-A: Getting the io^{TM} digital pen to market, Case Study prepared by Atul Pahwa under the supervision of Prof Jean-Philippe Deschamps, IMD, 2003.

In the spring of 2003 Company-A's management hived off the io^{TM} from the Retail Pointing Devices Unit, which had housed it so far, and set it up as an independent product unit, reporting directly to the head of the Control Devices Business Unit.

By July 2003, the feedback from the retail front, both from the US and Germany, was starting to flow in. The two market launch teams, who had run their shows individually since January, were planning a formal get-together for a first exchange of experiences. The senior management advisory team was also expected to meet shortly to review the results so far. These results varied significantly between the US and Germany. In the US, despite the fact that sales volumes were not what management or the team had hoped, the launch was judged "reasonably successful." In Germany, however, results were not really what Company-A had envisioned.

5.3 Company-B Case Study

Company-B was awarded the International James D. Watson 2003 Helix Award from the Biotechnology Industry Organization (BIO) in recognition of the Company's outstanding leadership and highest standards of scientific and product achievement.

5.3.1 Company background

Company-B is based in Geneva, Switzerland, founded in 1906. Company-B is a global biotechnology leader – the third largest in the industry based on revenues- with over 4,902 employees. The company has, in 2004, worldwide revenues of USD 2.458 billion (Figure 5-7) and a net income of USD 494.2 million (Figure 5-8). It has eight biotechnology products on the market and a strong pipeline with over 30 ongoing development projects, based both on proteins and small molecules.

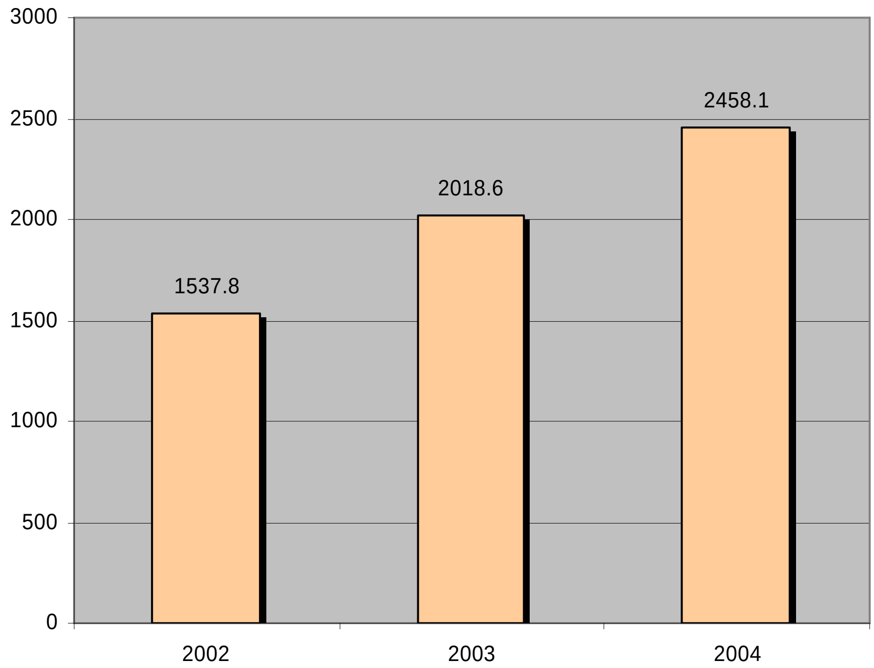

Figure 5-7: Total revenues from 2002 to 2004 (US$ million)
(Adapted from: Company-B annual reports 2002, 2003, and 2004)

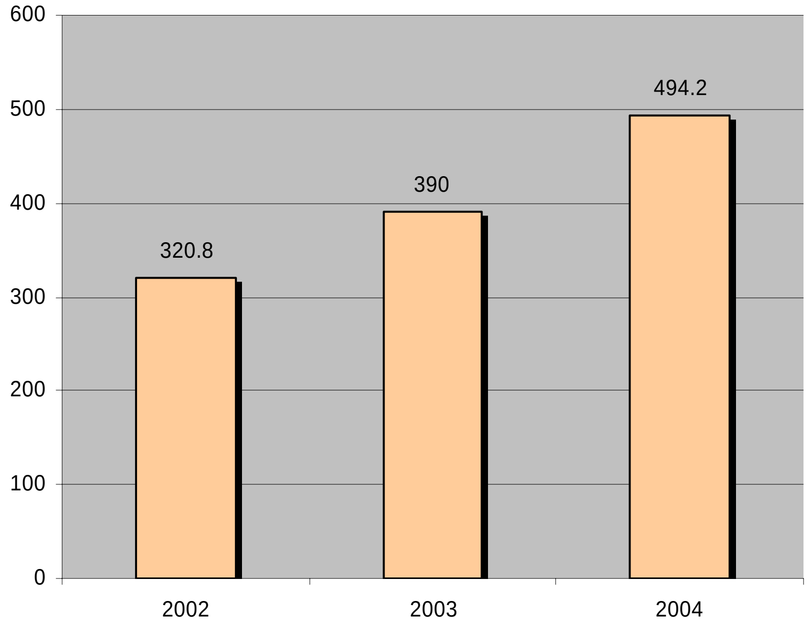

Figure 5-8: Net income from 2002 to 2004 (US$ million)
(Adapted from: Company-B annual reports 2002, 2003, and 2004)

5.3.1.1 History, milestones and development of Company-B

Table 5-3 shows milestones in Company-B international development up to 2004.

Table 5-3: Company-B milestones from 1906 to 2004
(Adapted from: Ares-Company-B Abridged, HBS, 1996; and Company-B annual reports 2004)

Year	Description of events
1906	Institute Farmacologio Company-B, established in Roma
1971	Company-B Laboratories, Inc., a subsidiary marketing pharmaceutical and diagnostic products, founded in the United Sates.
1972	Italian over-the-counter market entered.
1973	Hypolab S. A. founded in Switzerland as main production and distribution centre for diagnostic products for all foreign markets except Italy.
1976	First marketing subsidiary opened in Argentina.
1977	Headquarters transferred to Geneva
1982-1988	Pharmaceutical production begun in Switzerland; new subsidiary, Company-B Diagnostic S.A. opened. Subsidiaries opened in Brazil, France, Israel, Japan, Sweden, and Spain.
1984	Laboratories Company-B S.A., a new facility for research, development, and production for the pharmaceutical branch, inaugurated in Switzerland.
1986-1990	Subsidiaries opened in Australia, Canada, Mexico, Portugal, Singapore, and Venezuela. Randolph, Massachusetts Subsidiary for R&D in genetic engineering expanded. New genetic engineering facility in Spain inaugurated. Capacity of pharmaceutical production unit in Aubonne, Switzerland doubled. Relations with Eastern European countries intensified.
1991	Regional development structure for the pharmaceutical division implemented.
1992	Over-the-counter division sold (products marketed only in Italy). Representative office opened in the Ukraine. Affiliate created in South Korea.
1993	Subsidiary created in Colombia, South America. One of two invitro fertilization clinics sold by Bioscience subsidiary. Filaxis, an Argentine manufacturer of generic drugs in the oncological sector, purchased.
1994	Bordeaux, France-based Sorebio S.a.rl., specialising in process development for cell-derived products and production services in the field of cell culture technologies, acquired. Diagnostic division sold to BioChem Pharma, Inc. of Montreal, Canada. Construction of new biotechnology manufacturing facility completed in Randolph, Massachusetts, U.S.A.

Year	Description of events
2004	
December	Company-B and CancerVax Corporation announced a worldwide collaboration for the development and commercialization of Canvaxin™, being developed for the treatment of advanced-stage melanoma. Company-B and Micromet are collaborating in the development of Micromet's MT201 (adecatumumab), a fully human anti-EpCAM monoclonal antibody with therapeutic potential in the treatment of a broad range of cancers. MT201 is currently in phase II clinical trials in prostate and breast cancer.
November	Company-B and Nautilus are working together to create and characterize a modified form of human growth hormone with improved pharmacological properties.
October	Company-B and Paratek Pharmaceuticals are working together to develop a novel non-antibiotic tetracycline-derived oral treatment for multiple sclerosis. Company-B launches Raptiva® in Germany as the first biological treatment for psoriasis launched in the European Union.
September	Company-B receives marketing authorization from the European Commission for Raptiva®. Company-B and ZymoGenetics have estabished a broad partnership to research, develop and commercialize novel protein and antibody therapeutics based on discoveries made by ZymoGenetics. The partnership includes the grant of exclusive, worldwide licenses to Company-B to develop and commercialize products based on Fibroblast Growth Factor 18 (FGF-18) and the Interleukin 22 Receptor (IL-22R), and an agreement under which the companies will co-develop products based on Interleukin 31 (IL-31).
June	Preliminary half-year results data shows sustained clinical benefit for moderate-to-severe plaque psoriasis patients treated with Raptiva® for 30 months. The new European Committee of Medicinal Products for Human Use, CHMP, gives a unanimous positive opinion to Raptiva®.
May	Company-B receives FDA approval for GONAL-f® Pen to treat infertility in the US. Raptiva® receives approval for the treatment of moderate-to-severe psoriasis patients in Argentina. Company-B announces new advance for infertilie couples with the approval of GONAL-f® Filled-by-Mass (FbM) Prefilled Pen in the EU, Switzerland and Australia.
March	Rebif® now available with the thinnest needle in a ready-to-use pre-filled syringe for the treatment of multiple sclerosis. Company-B and IVAX announced positive outcome of pharmacokinetic trials with oral cladribine. Raptiva® (efalizumab) approved in Switzerland, the first approval for the psoriasis treatment outside of the US.
February	The European Commission approves GONAL-f® Filled-by-Mass Prefilled Pen. Company-B announces record year with over USD 2 billion in revenues.

5.3.1.2 Company-B at present

Currently, Company-B S.A. has a global presence with operations in more than 40 countries, production facilities in four countries and sales in over 90 countries. Company-B has, in 2004, total product sales of USD 2,178 million (Figure 5-9). It has spent 24.2% of total revenues on research and development in 2004. Company-B has integrated operations that allow it to manufacture and market the products the company derive from its research and development efforts. Company-B global sales and marketing infrastructure has made it a global partner of choice in the biotechnology industry.

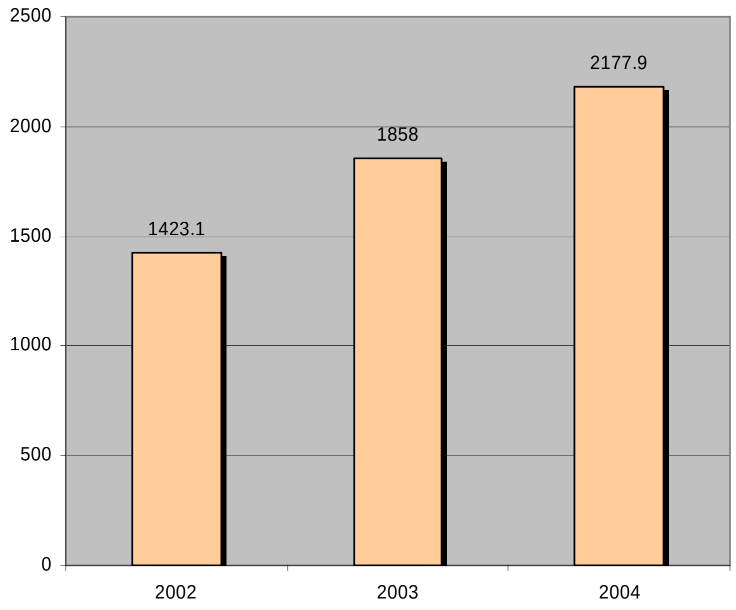

Figure 5-9: Total product sales (US$ million)
(Adapted from: Company-B annual reports 2002, 2003, and 2004)

Company-B S.A., a holding company organised under Swiss law with registered offices in Canton Vaud, Switzerland, controls, directly or indirectly, all affiliates of the Company-B group worldwide. The Company-B group's headquarters are located in Geneva, Switzerland. Company-B maintains research and development facilities located in Switzerland (Geneva), the US (Boston area), France (Evry), and Italy (Rome and Turin). Its principal manufacturing facilities are located in Switzerland (Aubonne and Corsier-sur-Vevey), Italy (Bari), Spain (Tres Cantos) and France (Martillace). Company-B operates business units worldwide, including in North and South America, Western and Eastern Europe, the Middle East, North Africa, South East Asia and Australia.

5.3.1.3 Technology

Company-B uses human genetic information to discover, develop and manufacture therapeutic products for the treatment of human diseases. It currently focuses on the specialised markets of neurology, reproductive health, growth and metabolism, and dermatology, the company's newest therapeutic area.

Company-B is the world leader in the treatment of infertility. Its vision is to develop and market innovative products to help infertile couples at every stage of the reproductive cycle, from follicular development early pregnancy, in making their dream of having a child come true. Company-B is the only company that uses recombinant technology to produce all three gonadotropin hormones for treatment of infertility and, with a complete portfolio of highly effective fertility drugs that cover every aspect of the reproductive cycle, it offers clinicians the ability to tailor treatment to individual patient needs.

5.3.2 Business overview

5.3.2.1 Cost pressure[1]

The pharmaceutical industry was transformed in the early 1990s by the consolidation of buyers and a change in payer roles, which dramatically increased buyer power. Buying decisions were increasingly made by managed-care providers such as health maintenance and preferred provider organisations and large purchasing groups such as corporations and large hospital chains.

The impact of these changes was particularly pronounced in the United States, which represented one-third of the world pharmaceutical market. Participants in managed-care plans accounted for 90% of total prescriptions by the end of the last century. Cost conscious managed-care providers had effectively replaced drug manufacturers and physicians as dominant force in the pharmaceutical industry. Managed-care providers used their clout secure discounts on bulk purchases of pharmaceutical and medical products and insisted that low-cost generics be used over brand-name products whenever possible. By the mid 1990s, U.S.-type health care reforms had extended to Europe. In 1994, the German government, having increased patient co-payments the year before, imposed a 5% price reduction on many drugs.

Company-B's core fertility product line evidenced an apparent insensitivity to health-care reform as long as patients had to pay for the treatment themselves. But when reimbursement of fertility treatments became an issue in the U.S. health-care reform debate in 1993, the company's U.S. sales dropped by 14% as infertile couples anticipating reimbursement delayed treatment. By 1995, the trend was towards reimbursement, with fertility treatments in France, Germany, and Spain (but not United Kingdom or Switzerland) fully reimbursed.

[1] Ares-Company-B Abridged, HBS, March 1996.

Management expressed considerable uncertainty about the impact of reimbursement on the sales and profitability of the company's core products.

5.3.2.2 Risk associate with product development

Downward pressures on price coincided with growing complexity in drug development and approval cycle, which drive up R&D and capital expenditures. The product-development cycle for an entirely new drug might be 10 to 12 (some even say 15) years, with development occurring in a number of relatively distinct, but also partially overlapping, phases. Development became increasingly structured as it moved towards the final phases of approval from health authorities.

Clinical trials- which in Phase I involved 50 to 100 healthy individuals, in Phase II 200 to 300 potential patients, and, in Phase III, more than 3,000 individuals in some cases – accounted for tow-thirds of total product-development costs. Firms applied to the authorities upon completion of testing and could begin marketing upon notification of approval. The cost of worldwide testing for an initial application of a new product was estimated to be $20 to $75 million. Approval by local governments added another $1to $2million par country or region[1].

The high-risk and research –intensiveness of the pharmaceutical business was reflected in the market. Only one in 5,000 compounds reached an end user. Of these, only 30% achieved the commercial success necessary to recover an average research investment, although patent law protected pharmaceutical products for as along as 17 years. A study released in the early 1990s estimated that $359 million and approximately 10 years were required to move a drug from test tube to end user, compared with approximately $250 million in the mid-1980s[2].

Pharmaceutical companies responded to these circumstances by ruthlessly challenging the success potential of products and compounds through centralised decisions-making at the top management level and, recognising the logistical difficulty of managing scientists around the world, attempting to leverage the next generation of products by coordinating far-flung R&D activities. Ultimately, the major challenge for managers continued to be to mediate the legendary conflicts between R&D, production, and marketing.

[1] Company-B Press Release and Company-B annual reports

[2] Company-B Abridged, HBS, March 1996.

5.3.2.3 Biotechnology alliances and mergers

Intensified competition and price pressure in global pharmaceutical markets fuelled merger and acquisition activity in what remained a highly fragmented industry. Acquirers instantly gained new products and customers and realised opportunities to reduce costs by rationalising, for example, sales forces and manufacturing and R&D facilities.

A succession of takeovers, alliances, partnerships, and mergers in the 1990s included Roche's acquisition of biotech pioneer Genentech, Ciba's purchase of a 50% interest in Chiron, and Amgen's acquisition of Synergen. At the same time, large pharmaceutical companies, in exchange for marketing rights under licensing agreements, were providing biotechnology firms with development funds, production facilities, and access to existing extensive sales organisations. Income from royalties and contract research added another $3 billion.

5.3.3 Company-B organisation structure and management

5.3.3.1 Structure

By the fall of 1995, Company-B had reconfigured its organisation around what it was called 'magic square' and reorganised the company. Figure 5-10 shows the structure of Company-B Group. The research and development corporate is the heart of Company-B. The top management of Company-B see R&D as the main engine for growth. With more than 1000 researchers, the R&D facilities are worldwide. Brining a new product to market had become a multinational effort. Research activities in Israel were carried out in a joint venture with the Weizmann Institute; in the United States, Company-B Laboratories assumed the leadership role in biotech research. Applications for research findings were explored at Interpharm in Israel, the Istituto de Ricerca Cesare Company-B in Italy, and the Laboratories Company-B in Switzerland. A development program typically involved more then one of these institutions. Figure 5-11 shows the R&D organisation chart for Company-B.

Although there are five main business units (BUs) at Company-B, the Research Division, unlike what most of pharmaceutical companies do, is not organised around these BUs. The research division is serving all the BUs, and doing research for all of them. However, Company-B had established a research division in Boston, USA, focusing only on reproductive health business unit. Later, Company-B found out that this division was conducting a very narrow research, and decided to broaden its activities to include other BUs.

5.3.3.2 Business units, products and their financial performance

In 2004, Company-B substantially increased total revenues and product sales, resulting in new records of $2.5 billion and $2.2 billion, respectively, with strong performance in both existing and new therapeutic areas. Double-digit products sales growth was driven by the lead product in each of the therapeutic areas. Net income increased by 26.7% to $494.2 million. Currently, there are five business areas at Company-B, each develop a group of products.

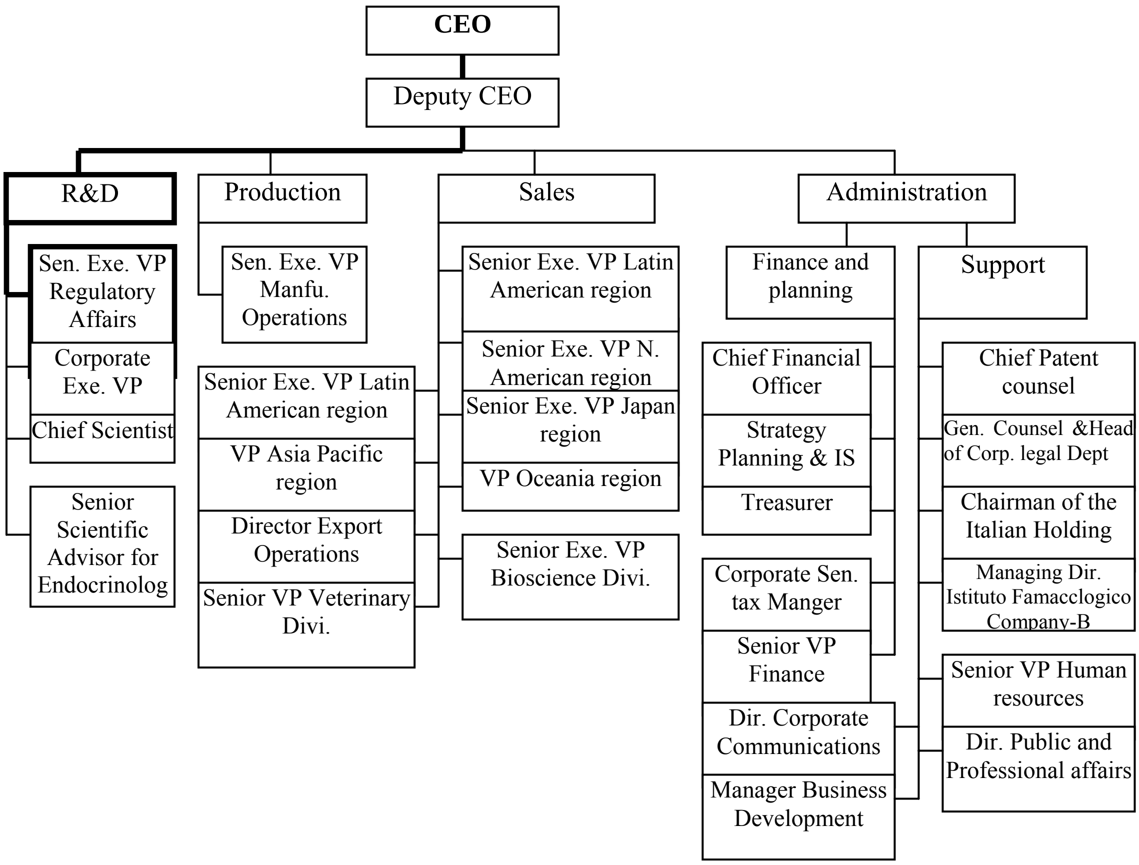

Figure 5-10: The structure of Company-B Group
(Company-B Abridged, HBS, March 1996; and Company-B Press Releases)

With an in-put from the Board of Directors (BoD), the CEO sets the vision for the company. This vision has to be in place for the next 3-6 years. The Executive Management Board (EMB) is responsible for setting the overall strategy of the company, based on the vision. Once the overall strategy is done, each business unit out of the five units at Company-B take the overall strategy and break it down into business units strategy. Then each business unit set down its own objectives and measures system to measure if the objective is reached within the scale time. They call that "cascade down organisation" which describing the steps from vision to objectives. The following are five main business units at Company-B:

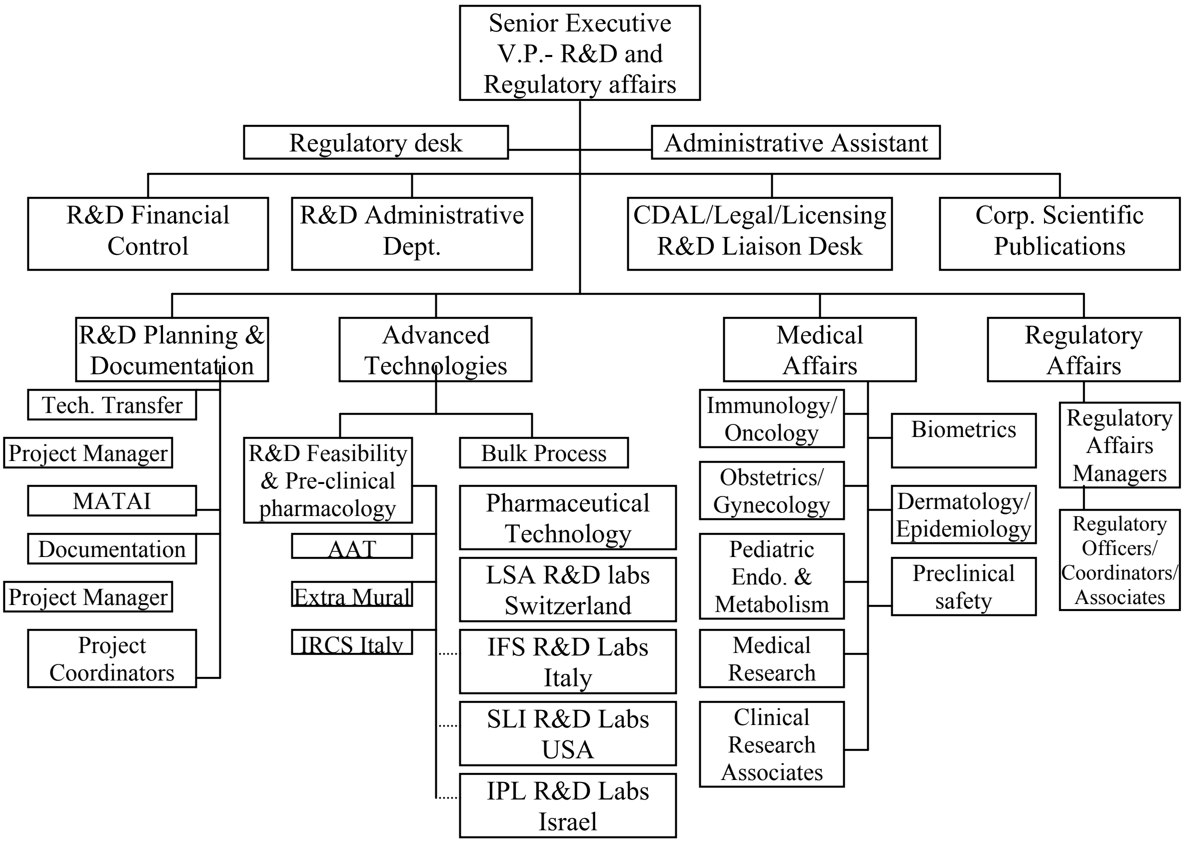

Figure 5-11: Organisation chart for Company-B's corporate R&D and regulatory affairs group
(Company-B Abridged, HBS, March 1996; and Company-B Press Releases)

Neurology business unit and its products[1]

In 2004, total neurology sales increased by 32.1% to $1,123.0 million, driven by Rebif®. This product showed an excellent performance in the US. Its US market share grew to 16.4% in total prescriptions and 18.6% in new prescriptions by the end of 2004. Outside the US, Rebif® maintained market leadership, with 35.5% market share in terms of sales.

Company-B is committed to supporting people with Multiple Sclerosis (MS). The studies demonstrated significant improvement in the three key efficacy measures of MS: reduced frequency of relapses, reduction in MRI lesion area and activity, as well as delayed disability

[1] Company-B annual reports 2002, 2003, and 2004.

progression. Rebif® is the only disease-modifying drug with proven efficacy on all three measurements of the disease.

The MS market is forecast to grow to between $5 billion and $6 billion by 2006, up from $3 billion in 2003. Company-B believes Rebif® is on track to achieve global market leadership by 2006: its long-term efficacy-particularly its proven ability to substantially delay disability-will lead to continued market share gains. In 2004, Company-B also markets Novantrone® in the US for those patients who progress from the relapsing stage of MS to secondary progressive.

Reproductive health business unit and its products[1]

As the world leader in reproductive health, Company-B is the only company with a full portfolio of fertility products for the main stages of the reproductive cycle, including the most prescribed gonadotropin in the world: Gonal-f®. Moreover, Company-B is the only company to offer the three recombinant fertility hormones.

Company-B unique portfolio of state-of-the-art fertility products, which includes Gonal-f®, Ovidrel®, Luveris®, Cetrotide®, and Crinone®, grew by 8.5% to $645.6 million. The Gonal-f® was launched in 2004 in 16 countries- Australia, most of Europe and the United States- as the first and only pre-filled and ready-to-use multi-dose pen for FSH (follicle stimulating hormone) administration. It is specifically designed for the treatment of infertility allowing patients easy and accurate delivery of a precise daily dose of recombinant human FSH.

In October the FDA approved Luveris®, the recombinant human form of the naturally occurring luteinizing hormone for women who have a server deficiency of FSH. Also, a new liquid form of Ovidrel® was launched in Europe and grew by 43.3%.

Growth and metabolism[2]

Company-B's commitment to innovation in this therapeutic area has given rise to indications for the Company growths hormone products: growth disorders in children; indications for its growth hormone deficiency in adults; AIDS wasting; and short bowel syndrome. Company-B

[1] Company-B annual review 2003; and Company-B annual reports 2002, 2003, and 2004

[2] Same reference

is the only company in the growth hormone market to offer a family of customer-focused injection devices. Company-B excels in developing such devices to help patients administer their treatment.

Saizen® and its cool.clickTM and one.clickTM delivery devices are backed by comprehensive patient and practitioner education, product support and a commitment to ongoing research on treating growth disorders. Saizen® sales in creased by 20.2% to $182.1 million in 2004. Serostim®, the only growth hormone therapy approved by the EDA for the treatment of AIDS wasting, achieved sales of $86.8 million in 2004.

Dermatology

In 2004, Company-B saw its expansion into a fourth therapeutic area, broadening its portfolio to include dermatology. In September, 2004, Raptiva® was approved by the European Commission for the treatment of patients with moderate-to-severe chronic plaque psoriasis in whom other systemic treatments or phototherapy have not worked or are inappropriate. Raptiva® was the first biological treatment for psoriasis to be authorised for marketing in the 25 countries, including Switzerland, Australia, Argentina, Mexico, and Brazil.

Oncology[1]

Company-B is committed to the development of novel targeted therapeutics for cancer. In 2004 Company-B entered into important collaboration and license agreements, which further demonstrate its commitment to expanding its portfolio of innovative clinical-stage projects that address significant, unmet medical needs.

In December 2004, Company-B and Micromet signed an exclusive collaboration and license agreement for the development and commercialisation of a fully human monoclonal antibody adecatumumab. The product is currently being tested in two multicenter, Phase 2 clinical trials for the treatment of prostate and metastatic breast cancer.

Also in December, Company-B entered a worldwide collaboration with CancerVax for the development and commercialisation of CanvaxinTM, a specific, active immunotherapy product being developed for the treatment of advanced-stage malignant melanoma, a deadly

[1] Company-B website and annual report 2005.

form of skin cancer. CanvaxinTM is currently being evaluated in two international, multicenter, Phased 3 clinical trials for the treatment of Stage III and Stage IV melanoma.

5.3.3.3 Research and development

Company-B has R&D in four different locations:

i. R&D centre in Geneva, Company-B Pharmaceutical Institute (SPRI) focuses on Company-B research strengths in autoimmune, inflammatory, and neurological disease. With over 200 scientists and staff, it is a global centre of excellence in understanding the biology of disease, as well as in progressing the concept into small molecule and protein drug molecules.

ii. In Boston, the Company-B Reproductive Biology Institute (SRBI) focuses on the field of reproductive endocrinology. SRBI was inaugurated in 1999 as a centre of excellence in Reproductive Biology. A staff of 70 researchers works on the commitment to breakthrough discoveries in biology together with the development of innovative new therapies for infertility and reproductive health.

iii. A pharmacological research centre located in Italy. Having a very close interaction with SPRI and SRBI allows an efficient and fast progression of drug candidate molecules through the safety and efficacy studies necessary to qualify a lead molecule for phase 1 studies.

iv. Company-B Genetics Institute (SGI), formerly Genset, which was acquired by Company-B in the second half of 2002, is a genomics-based company focused on generating a pipeline of drug targets and drug candidates in the areas of CNS and metabolic disorders.

In addition, Company-B has a long standing collaboration with the Weizman Institutes of Science, providing it with new therapeutic molecules in the area of immunology. Table 5-4 shows the highest priority R&D projects at Company-B.

Table 5-4: Highest priority R&D projects at Company-B
(Adapted from: Company-B annual report 2004)

	Preclinical	Phase 1	Phase 2	Phase 3	In Registration
Reproductive Health					
Prostanoid FP receptor antagonist in pre-term labor					
Oxytocin receptor antagonist in pre-term labor					
Onercept (r-TBP-1) in endometriosis					
Anastrozole in ovulation induction and improvement of follicular development					
Gonal-f® (Japan)					
Neurology					
Osteopontin remyelinating agent					
MMP-12 inhibitor in multiple sclerosis					
JNK inhibitor in multiple sclerosis					
Mylinax® (oral cladribine) in multiple sclerosis					
Rebif® vs. Copaxone® head-to-head in mutiple sclerosis					
Metabolism					
PTP1b inhibitor in diabetes and obesity					
Serostim® in HARS/lipodystrophy					
Saizen® in small for gestational age babies					
Dermatology					
Raptiva® (efalizumab) in psoriasis (additional countries)					
Autoimmune/Inflammatory Diseases					
Kappaproct in inflammatory diseases					
Tadekinig-α (r-IL-18 bp) in autoimmune diseases					
TACI-Ig in rheumatoid arthritis					
TACI-Ig in systemic lupus erythematosus					
r-Interferon beta in chronic hepatitis C in Asian patients					
Oncology					
TACI-Ig in relapsed/refractory B-cell malignancies					
TACI-Ig in multiple myeloma					
Adecatumumab in prostate cancer					
Adecatumumab in metastatic breast cancer					
Canvaxin™ in stage III melanoma					

Glossary:
HARS HIV-associated adipose redistribution syndrome
JNK Jun kinase
LH Luteinizing hormone
MMP Matrix metalloprotease
PTP1b Protein tyrosine phoshatase 1b
r-IL-18 bp Recombinant interleukin-18 binding protein
r-TBP-1 Recombinant tumor necrosis factor binding protein 1
TACI-Ig Transmembrane activator and CAML-int eractor and immunoglobulin conjugate.

5.3.4 Generic NPD process model at Company-B

In general, we can distinguish two major "parts" in the structure of a biotechnology project[1]:

i. *Research and development* - screening and testing of the potential drug candidate. In pharmaceutical industry in general and in Company-B specifically, the actual development phases are more expensive than the research part. This is due to the fact that these phases deal more with human trails which are very costly. In the trails, as much as 400 to 500 patients have to be very carefully overseen by medical doctors, and every thing happen has to be written down and all the data should be collected and carefully analysed by these doctors for each individual patient.

ii. *Commercialization* - establishment of marketing and sale force, and implementation of large-scale drug production.

5.3.4.1 Research and Development

The process of drug development is lengthy, complex, and risky. Before a new drug can be marketed, it is rigorously reviewed by a special governmental agency. The approval, provided by this agency, gives the company the right to launch the drug onto the market in the designated indication.

Because of this regulation, the process for drug development is somewhat standardized and formalised in the sense that it is composed of several discrete stages. The main activities in each phase are to some extent known (e.g. the number of human and chemical studies and tests in each phase, how many patients, and where to take them – the studies in USA cost as much as the double of those in Europe – and possible out put of each phase). Based on these activities, a speculated or a theoretical development time and cost for each phase are drawn. As shown in Figure 5-12, the research and development process at Company-B for a new drug is divided into six major phases:

i. Discovery
ii. Pre-clinical research
iii. Clinical phase I study
iv. Clinical phase II study

[1] Borissiouk, O. and Peli, J. 2002. Real option approach to R&D project valuation: Case study at Company-B international S.A., Master Thesis, University of Lausanne.

v. Clinical phase III study
vi. Regulatory review

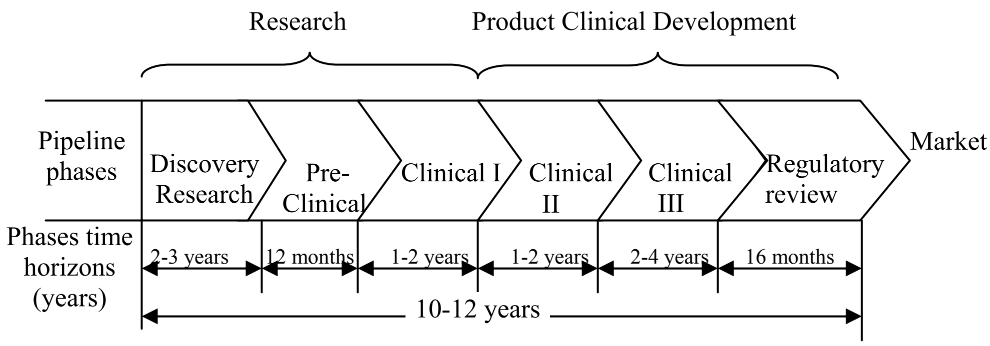

Figure 5-12: NPD process at Company-B and its speculated time horizons

Discovery research

The most important part of this stage is the discovery of a key molecule. It involves an understanding of the molecular mechanisms provoking the target disease, and the screening of chemical or biological molecules. However, in this phase, the researches don't know which molecules will get through the development pipeline phase. As a matter of fact, in Company-B, 99% of the research in this phase never reaches the market. In other words, the leads is only 1% of all researches conducted at discovery phase. It is quite difficult to find molecules compound or protein that meets all the requirements of all phases, which is safe and can be used for human.

Once the molecule has been found, researchers have to prove that it is effective for a particular disease area and for this target of population. In general, the more the product advance in the pipeline, the better the chance to get succeed. As the development phases are extremely expensive, the Company-B project leaders have wisdom says: kill it as soon as possible.

Pre-clinical research

"Investigate safety of a product candidate in a controlled laboratory environment."
The chosen molecule is being investigated in both laboratory experiments and animal models for potential safety and biological activity. These trials normally involve toxicity tests on different animal species, usually rodents (rats, mice) and non-rodents (dogs, monkeys). A patent is filed in order to ensure the proprietary position on the market.

Whilst the pre-clinical phase is ongoing, many other pharmacology activities are being performed. Chemists test manufacturing techniques, and different formulations of the drug are being examined to establish drug stability.

As the result of this research, a candidate drug is selected with the conclusion that it may be useful in treating sick patients in the target therapeutic area. The length of this stage is very difficult to estimate, as the time of a discovery is almost unpredictable.

Phase I clinical study

"Clinical trials in healthy volunteers to determine safety, dosages and the best route for delivery of the medicine."

Once the pre-clinical study is completed with favourable results, the drug candidate is filed to apply for permission to administer to humans. Namely, a committee must ethically approve these trials, as for any others and the volunteers must be closely monitored throughout the study. When authorities give their ethical approval, the potential drug is then tested in the frame of clinical phase I on 20 to 80 healthy volunteers. The primary goal of this stage is to assess safety, tolerance and drug metabolism in humans. These trials may last one or two years.

Phase II clinical study

"Clinical trials in patients to further determine dose, safety and efficacy."

Phase II clinical studies are carried out to investigate the effect of the potential drug on patients. This is the first time when the drug candidate is tested to treat the targeted disease on sick people. The objective of this phase includes verifying the biological effectiveness, controlling side effects, and obtaining dosing information. These trials are carried out on 100 to 300 sick patients and may last one or two years.

Phase III clinical study

"Large clinical trials to determine definitive safety and efficacy in patients."

Phase III study involves thousands of patients, and is, therefore, the most important and costly part of the drug development process. This phase is the major efficacy and safety trial performed in the patient population. It provides further documentation and substantiation of therapeutic effects and expands knowledge of side effects, toxicity, and general safety of the drug candidate. Since the trial is accomplished on a much larger population of patients, it provides the critical sample size for statistical analyses. The experiments are typically double blind using randomization and test versus control groups. It can also include comparative analyses of the drug candidate against a rival drug.

Consisting of 1000 to 3000 sick patients, phase III trials are of an order of magnitude larger than that of phase II trials, and therefore may last two to four years.

Regulatory review

When the clinical studies have been completed with a successful outcome, documentation detailing their results is assembled and submitted to the governmental agency for approval. This documentation is known as a Product License Application in the case of a biopharmaceutical, or New Drug Application in the case of a traditional pharmaceutical company. The agency responsible for US approval is the best known Food and Drug Administration (FDA) and for the European approval the European Medical Evaluation Agency. If the FDA approves the drug, it is also authorized in Japan. These agencies are noted in our manuscript as FDA. FDA takes about one year to review the application. It may approve the drug for the indicated therapeutic area, but may ask for additional information or studies, or may not approve the drug.

It is important to know that during the approval phase governmental agencies fix a price of the developed drug prohibiting any future changes of it. Thus, a part of the project economic uncertainty, represented by price uncertainty, disappears after this phase.

After the regulatory authorities have approved the drug, a phase IV study may take place. This phase intends to study unanswered questions including specific drug interactions, genetic factors, and dosage modifications for extreme of age. In addition, this phase is designed to determine long-term safety issues.

5.3.4.2 Commercialization

Drug sales begin immediately after obtaining a green light from the required authorities. Thus, a manufacturer sets everything to launch as soon as approval is granted. To ensure these immediate sales, a preparation of the market launch is carried out already at Phase III. The positive development at this phase gives sufficient indications that the drug candidate may turn to a real drug soon thereby providing the bases to start concrete marketing activities.

Moreover, construction of the necessary sale force may also begin one year before the estimated launch at the same time as the documentation is filed in to obtain FDA approval.

Merely 1 out of 4000 discovered molecules results in an FDA approved drug. 1 out of 5 drug candidates that entered Phase I trials may reach the market. It means that approximately 70% of drugs entering this stage also enter the next phase of development (Phase II). 47% of drug candidates pass from Phase II into Phase III trials. 82% of candidates in Phase III pass the next phase. And finally 90% of submitted drugs are approved by the FDA1. Importantly, the risk represented by the technological uncertainty (success in R&D phases) may only be resolved within 10 to 12 years of the R&D process. In addition, the substantial risk that was accumulated by these factors is further intensified by the fact that the entire development process including launch costs may reach $200 million.

5.3.4.3 NPD project management at Company-B

There are two committees for monitoring and controlling the NPD projects at Company-B. Those two committees covering all the development process in the five business units. The first committee, *research supervising committee*, is responsible for the research phases (which include: discovery research phase, pre-clinical phase, and clinical phase I). The second committee, *product development supervising committee*, is responsible for monitoring the development phases II & III and the regulatory and registration, in addition to the overlaps between phase I & II (between the end of the research phases and development phases).

The research supervising committee and the product development supervising committee are chaired by the head of research group and the head of development group respectively. Both heads are represented in the Executive Management Board (EMB) and delegated by it to follow the NPD projects.

Research phase at Company-B

One of hardest things in pharmaceutical researches is to keep a focus on what the company wants to accomplish. It’s very easy in this type of research to be distracted to interested pieces which have no thing to do with the path the company would like to follow. To avoid such diversion, Company-B has setup a formal process to review and select the target molecules as they evolved.

There is a formal mechanism for selecting target molecule that the discovery group has to work on, and that will proceed in the development pipeline. There are three main entities interacting with each other to select the right molecule: product marketing people, executive management board (EMB) including the CEO, and the discovery people.

The discovery group, as a result of their intensive research, comes up with a lot of ideas, date and information about possible molecules. The group tries, in terms of research, to focus on a certain molecules, as the available resources do not afford working on all of them. The product marketing people, which obviously reflect the main competence of Company-B, advice the discovery group about the market needs (e.g. what type of product is needed the most, what disease has to be attacked, etc.). Both groups come to the EMB with possible molecules. The EMB select the strategic molecules that may turn into new products that may improve the growth of Company-B.

Company-B also has an electronic system, which was developed in-house, named: “SNAP” (Company-B New Approval Process). SNAP is an electronic process enabling the employees to introduce their ideas, and having these ideas approved by the right people at Company-B, with potential of receiving resources and support for more investigation. In some cases, due to certain factors related to cost, time or strategic issues, the system pushes the ideas up to another level of decision making, so that it get reviewed by the top management.

Development phase at Company-B

Unlike development projects in other industries, it is almost impossible to assign one project manager and one team to conduct an entire biotech project, from idea to market. This is due to the long development cycle time of biotech projects (10 to 12 years). The NPD projects are broken down into sub-projects.

At Company-B, any development project is divided into three main sub-projects. Company-B deals with each one as a stand-alone project. Each sub-project has its own project manager, team, resources, and external partners. In addition to that, each sub-project has to set-up a sub-project plan, in terms of development time and cost. The first sub-project includes preclinical (e.g. investigate safety of a product candidate in a controlled laboratory environment) and clinical phase I (clinical trials in healthy volunteers to determine safety, dosages and the best route for delivery of the medicine). The second sub-project includes clinical phase II (clinical trials in patients to further determine dose, safety and efficacy) and clinical phase III (Large clinical trials to determine definitive safety and efficacy in patients), in addition to a part of regulatory review. The third sub-project includes the regulatory review and marketing (commercialisation of the product). As soon as a sub-project team finish their activities, they (team) “through” the results to the development team of the next sub-project. The later sub-project team have to evaluate the work and set-up their own plan. These three sub-projects are shown in Figure 5-13.

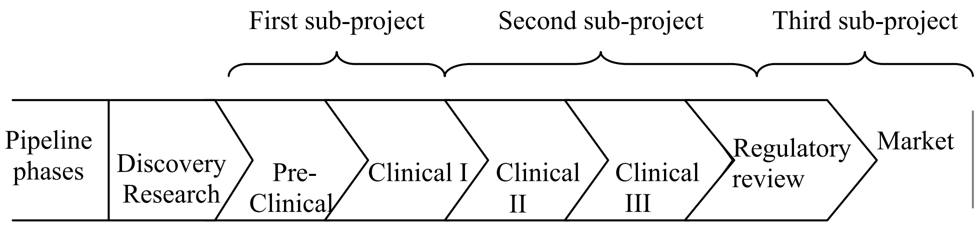

Figure 5-13: The three sub-projects at Company-B development project

At Company-B, there is a standard process for managing the development projects. This management process is well documented, and shows what input required from the team, what resources needed, how much time and cost for development, what documents and information the team have to present to get the approval from the top management.

Company-B has what it called “light bureaucracy.” It is an approach the company follows to control the development projects. The control is made based on the amount of money the project mangers requested for the development activities. The more the amount of money required, the more the involvement the top management in the project. To some extent, this control process may result in wasting some times in waiting for top management decisions.

The involvement of the top management in decision making related to the development project depends on the kind and consequence of the decision. All the decisions related to how the team conduct the development activities are taken by the project team themselves. Any decisions related to cost, time or quality of the product (decisions related to the project plan), the development team should forward it to the top management.

5.3.5 ORA development project at Company-B

5.3.5.1 Introduction

The Oxytocin Receptor Antagonist (ORA) project is one of the current Reproductive Health (RH) business unit's projects. As mentioned earlier, Company-B is the world leader in the treatment of infertility. The company's vision is to develop and market innovative products to help infertile couples at every stage of the reproductive cycle, from follicular development to early pregnancy. As the only company that uses recombinant technology to produce gonadotropin hormones for the treatment of infertility, and with a complete portfolio of highly effective fertility drugs that cover every aspect of the reproductive cycle, Company-B offers clinicians the ability to tailor treatment to individual patient needs.

5.3.5.2 ORA project description

The ORA project was considered at Company-B a new domain of products. This project deals with delivery period (and not the early pregnancy period as the other RH products). It aims at developing a drug that enables pregnant women to delay their contraction until the right time for delivery (i.e. when the mother gets a contraction, the product tries to stop this contraction, so that the baby stays inside the mother longer, until the right time for delivery).

Due to the length of the project, I could not cover the full phases of the project, as that would mean covering 12 years of work. So, I focused on the first sub-project of ORA project (preclinical and clinic phase I), which was recently completed. The development of this subproject took three years and half. Moreover, I investigated also the research part of the project (discovery research) which took two years and half. In this sub-project, Company-B studied and tested the formulation in women. After receiving the results, the formulation was optimised and improved. The outputs of this sub-project were already submitted to the next sub-project team to start the clinical phases II and III.

5.3.5.3 The ORA project characteristics

As is the case with most biotech projects, the ORA project development activities involved substantial technological complexities. Multiple competencies and new technologies were required from Company-B and its partners. The output of each single activity was unpredictable, having been based entirely on the results of the tests made on either animal or human being in latter stages.

As mentioned earlier, the development cycle time of this sub-project was six years. The average number of tasks to be executed on monthly basis was not extensive. In addition, the nature of this industry does not permit parallel task execution. Instead, tasks were carried out consecutively, with the output of one task constituting the input of the next. The average ‘unit-time’ to execute a task in the ORA project was two to three months. These characteristics explain why the development progress was measured quarterly.

5.3.5.4 ORA project manager role

The ORA project team was responsible for setting the project plan. As the project team consisted of different functions’ representatives, each function drew up a plan for their own contribution (e.g. the formulation people made a contribution in the following areas: how to obtain full information about the target, how to test it, when to use the materials for clinical study, etc.). The project manager’s task was mainly to bring together all contributions and coordinating in-puts of different activities of different functions within his subproject. When the plan was drawn, the project manager presented it to the top management for assessment and approval. The decision making processes were formalised, so that every one involved in the project knew what had to be done.

However, due to the nature of the biotech industry, the project plan (mandate) was, to some extent, “loose”. The top management knew that the project team could not be more precise, as the output, in this industry, is not straightforward. As a matter of fact it is not always possible to develop what the product development team plans.

The project manager was not the one who controlled the project budget. Rather, the financial issues were controlled by a separate central function at Company-B called the finance department. This function held the budget of the on-going-development projects, so that the resources for ORA project were allocated relative to other projects. The ORA project manager was not responsible for selecting the project partners and suppliers, or even the appointment of NPD project team members. In fact, he was only coordinating the different activities involved in the project.

5.3.6 ORA project strategic partners

Partnering with biotechnology and pharmaceutical companies, and leading academic institutions, is an integral part of Company-B's strategy to be a world leader in biotechnology. Company-B represents to its partners a combination of characteristics which are uniquely Company-B, including: i) a track record of success in developing, registering and commercialising innovative pharmaceuticals worldwide; ii) an innovation-driven, entrepreneurial culture; iii) a responsive management; iv) organisational transparency; v) clear strategic objectives; vi) substantial financial resources; vii) a leading, fully-integrated capability in the manufacture of recombinant protein products.

As it has been stated before, Company-B partner with other biotech and pharmaceutical companies to have an access to resources and expertise that it does not has. This collaboration can be centred on one phase of the development, or on entire development phases. On the other hand, the collaboration can take different scenarios. For instance, when the discovery research at Company-B find out an interested molecule and the four business units at Company-B do not have the necessary capability, expertise or resources to develop this molecular in-house, Company-B follows one of the following scenarios: i) sell the new discovered molecule or compound to other company; ii) if the molecular can be developed partially by Company-B, the company tries to find out other partners to execute the activities Company-B cannot; iii) if the molecular of possible strategic importance for the future business of Company-B (e.g. Oxytocin receptor antagonis), Company-B asks another strategic partner to develop the entire product for Company-B. In this approach, Company-B will have the final product and will build gradually its expertise in this product.

5.3.6.1 Criteria and decision making for partner selection

Partner selection issue at Company-B has two different levels, operational and strategic levels. That is why the decision has to be taken jointly by the top management and the functional department, to which the candidate partner may participate. For example, the Industria Farmaceutica Company-B Laboratories, located near Rome, in Italy, supports the development of Company-B's new products and improvement of existing ones, by setting up innovative formulations and analytical methods in the field of recombinant proteins. This group, as expert in drug development, is involving in selecting the partners in the drugs delivery field. The group screen, worldwide, companies who are experts in this domain, select the best possible partner based on its functional expertise (what can bring to the company to improve the product development). Then, the top management will look at the strategic aspects of this partnership (partner vision and strategy, current and future business, short-term returns, long-term potential, etc.).

There are certainly criteria for partner selection. The criteria are reviewed by committee and top management. There is a hierarchy of criteria. The first and the most important one would be if there is a potential output that can come out of alliance in direct way or in a short period of time. This should be in one of Company-B therapeutic areas. The next criterion is that the product of the candidate partner could be in completely new therapeutic area for Company-B, but in this case, the product should be extremely strong and revolutionary one. Company-B is interested in niche areas- very narrow area of research where there are no many competitors.

The third criterion has no thing to do with R&D. It is about product distribution. One of most important partners for Company-B is Pfizer. This company is one of the largest companies in the world, and based in USA. Pfizer has very large sales force, and co-promotes Company-B's Rebif® in the USA. There are two reasons for this partnership. The first, Company-B was competing against Biogen, which is already very well-established in the United States. It was very difficult for Company-B to quickly hire sales force to promote the product (Rebif®) in the United States. To overcome this problem, Company-B decided to partnership with Pfizer for promoting its products in the US. The second reason was that the need for this product was growing very fast in the US and the rest of the world. In order for Company-B to distribute its product and meet the increase in the market demand, it was important to partner with Pfizer.

5.3.6.2 Relationship between Company-B and its strategic partners

An alliance is an excellent and flexible way of combining strengths while economizing resources. Company-B relationship with its partners differs from case to another, based on the nature of the partner (e.g. industrial partner or academic).

Relationship with the industrial partners

So far Company-B is not gone down the acquisition road very often. In fact, Genentech was the last acquisition for Company-B, and that happened few years back. Company-B prefers to buy equity then to give the company money upfront (will be detailed in the next sections).

This is of course depends on the partner. If it is good one that means its equities will increase over time, and this is in itself a good investment for Company-B.

Company-B has traditionally preferred programs where it collaborates with other partners. This is done by defining an area of collaboration, where both sides agree about the goal of collaboration, how to achieve it, the amount of money they should spend, how much efforts both sides should put in the project, and the milestones along the NPD process to check the collaboration. This is the favourite approach for Company-B.

This approach is not a type of research contract (e.g. we pay you this amount of money and you do this and that for us). It is much more like saying: you are the expert in this particular area of Biology, and we would like to work on this area, but we (Company-B) don't have as much expertise on this area as you (partner) have, we are very good in marketing and development in the later stages, so why don't we collaborate. You provide the first part, with a support from us, and we provide the latter part, with a support from you.

Relationship with the academic partners:

The collaboration with the academic partners is more focusing on specific ideas and programs. Company-B support research program or buy intellectual property. Some times the academic part offers Company-B an exclusive licence arrangement, and very rare when they sells the patent of the IP, as it owned by the university or institute where this research has been done. This is the reason why Company-B tries some times to come to an arrangement to allow it to use the research results without buying the IP, which known as an exclusive licence.

5.3.6.3 Partners participating in ORA project

There were many different technologies that had to be applied in the development of the ORA project, some of which were not available at Company-B. A big part of these technologies came from external partners.

The basic molecule for ORA project was discovered and patented by Company-B discovery research. This molecule was considered a breakthrough for Company-B and may open a new market. The company has neither the expertise nor the resources to develop this molecule. Although Company-B prefers to develop its products in-house, in the ORA project, due to the lack of relevant expertise and resources, it decided to outsource a considerable part of this project to external partners. The goal of Company-B was to develop this product and, at the same time, build a good knowledge and expertise in this domain by learning from the project partners. To do so, Company-B hired experts in this specific domain so that by the end of the project, Company-B would have had all the needed expertise to continue developing such projects in-house. This is a part of the technology transfer policy at Company-B. To support this policy, Company-B had equity investment in some of the project partners.

Some of ORA project's strategic partners are shown in Table 5-5. It is worthy noting that in this case study I only focus on the relationship between Company-B and its project strategic partners in whom the Company had equity investments. These companies are: Evotec, Amard, and Alkermes.

Table 5-5: Strategic partners for the Reproductive Health business unit

Strategic Partner name	Type of relationship	Phase	Main activities
Evotec OAI Medium (646 employee)	Equity-based partnership (minority holding)	Pre-clinic and Phase I	Evotec OAI offers the full range of high-value added products and services required to discover and develop drugs. By integrating accelerated methods in biology, chemistry and screening, the Company has established a unique position as a one-stop-shop for all the critical elements in the drug discovery R&D process from target to clinical development. Evotec collaborated with Company-B in developing ORA product.
AstraZeneca (large)	Joint development agreement	Development phases clinical II & III	Under an exclusive worldwide license from AstraZeneca, Company-B is developing anastrazole as a treatment for ovulation induction and improvement of follicular development.
Columbia Laboratories (small)	------------	Marketing	Company-B markets Crinone® under an exclusive worldwide license from Columbia Laboratories
Amrad (Start-up)	Equity-based partnership (minority holding)	Development phase clinical I, II & III	Company-B is developing rhLIF (recombinant human leukemia inhibitory factor) in the field of reproductive health under an exclusive worldwide license from Amrad. The Company participated also in the ORA project.
Alkermes (small)	Equity-based partnership (minority holding)	Development phase clinical I, II & III	Company-B is developing a microsphere formulation of rhFSH (recombinant human follicle stimulating hormone) produced in partnership with Alkermes using Alkermes' ProLease® technology. Collaborating with Company-B in developing ORA product
Pfizer (Large)	----------	Marketing	Pfizer co-promotes Company-B's Rebif® in the United States.
Zentaris	----------	marketing	Company-B markets Cetrotide® (cetrorelix acetate) in all countries except Japan under an exclusive license from Zentaris (formerly ASTA Medica).

5.3.6.4 Conflict between ORA project team of Company-B and strategic partners

The ORA project involved partners with different cultures, size, capabilities and ultimate objectives. A certain amount of conflict, therefore, was inevitable. Many of the conflicts that came up during the course of the project were the result of misunderstandings or unclear or misread signals among the partners. Clearly and well-defined responsibilities and priorities could have avoided some of the problems.

Some problems between Company-B and its partners were related to the difference in priorities. This was sometimes the case even internally, between the functions within Company-B. When an activity was important for Company-B and had to be delivered by a partner, Company-B expected that partner to allocate enough resources to get the job done on time. On the other side, if this particular activity was not a priority for the partner, it may not have concerned the partner as much, and the partner would invest the resources in doing something more important for his business. As a consequence, the level of communication and coordination between Company-B and this partner were minimised, resulting in delay in the development project.

This problem was very clear with a small-sized company, or start-up, working with Company-B. The whole business of the small company depended on the success of the project they are working on with Company-B. On the other hand, Company-B had many other projects on-going in its development pipeline, some of which were even more important then ORA project. The priority, in terms of focus and resource allocation between the two companies was not the same. The difference in priority was reflected in the communication between Company-B and this partner. During the development phases, the small-sized company (Amrad) complained that the development team of the ORA project team was not quick enough in communicating issues, and submitting reports; in addition, there were delays in the decision making process. This resulted in extreme frustration for Amrad, making it feel lost in the bureaucracy of Company-B. There was also a different enthusiasm between both companies. For Amrad, the project success was very important and a matter of existence, while for Company-B, the failure of one project did not mean losing the business. These things led to mistrust and miscommunication between the two companies.

Company-B knows that a moderate degree of conflict in an alliance can be quite healthy and a stimulus to creativity and improved performance. The key is to have a process in place that will keep conflicts from getting out of hand and causing serious disruption to Company-B. Hence, Company-B has strived to reach agreement as to how conflicts among the parties were to be handled. Company-B has, jointly with the partners (Evotec, Amard, and Alkermes), created three counsels aiming at monitoring the partners' relationships and solving problems while they were small. These three counsels were: joint research counsel, joint collaboration counsel, joint decision making counsel. Those counsels consist of an equal number of people from Company-B and the partner. However, because Company-B was responsible for the entire process of the project, it was agreed that in case these three counsels couldn't reach an agreement, Company-B had the deciding vote. If the partners could not agree, they would forward the subject to the two CEOs of the companies to make the decisions. This is generally what Company-B has to do with each strategic partner.

5.3.7 Integration process elements with the strategic partners during the ORA project

In this section, I investigate the average intensity of communication and coordination between the ORA project team of Company-B and the project strategic partners' teams, specifically, those in whom Company-B had equity investment: Evotec, Amard, and Alkermes.

Company-B project teams are aware of what could be the consequence of miscommunication and lack of coordination of activities with the strategic partners. Company-B differentiates between its strategic and non-strategic partners. This can be seen in the difference in the amount of information flow and the resource sharing with both strategic and non-strategic partners. With the non-strategic partners, the amount of information and resource sharing is very limited, just what is necessary, with both sides (Company-B and the non-strategic partner) following the contract items word for word.

5.3.7.1 Communication with the ORA project partners

In this section, as stated in the previous case study, the two elements of communication – frequency of communication between ORA project team of Company-B and their project strategic partners, and thee flow of information between them – are presented. I found these two elements to be interrelated and I will not describe them independently.

As with other of Company-B's projects, the frequency of communication with, and the amount of information flow between ORA project partners were different from one phase to another, based on the communication needs of each single phase. The communication also took different forms such as face-to-face meetings, video teleconferencing, and email exchange.

At the ORA project, there was only one channel of communication with the three strategic partners: Evotec, Amard, and Alkermes. The communication between the ORA project team and these partners was centralised and occurred mainly through a defined channel. The project manager appointed the formulation group representative to be responsible for the contact with the partners. All the communication between the ORA project team of Company-B and their partners had to be made through this point.

Due to that fact that the strategic partners' teams were geographically distributed teams – in different European countries and USA – it was difficult for the teams to meet face-to-face on a frequent basis. There was, therefore, a need for a communication medium and protocols to manage and control execution of the activities. Video conferences seemed to be a good method for holding meetings. In the video conference meetings, some people participated on a regular basis. Those people were the project manager and the representatives of the following functions: formulation, safety, and discovery. Each one discussed issues related to his function. These video conferences took place each three months. Apart from these video conferences, communication for controlling and monitoring the project progress was done by the formulation representative. During the development of the project, it was very rare that an informal contact occurred between the ORA project members of Company-B and the project partners.

Since the very beginning of the project, the ORA project development team agreed about the means of communication with their project partners. Both have drawn a formal communication plan, with certain rules on how to communicate. This included: who should be involved, who should communicate with whom, who should be informed, if that person was not there who should be his replacement, when information has been requested; how long it should take to get a response. The idea behind this was to streamline the process of communication and facilitate the information flow between partners.

During the ORA project, there were face-to-face meetings, two to three times a year, with each of the three strategic partners; Evotec, Amard, and Alkermes. It did not happen during the course of the project that the three partners met all together. In the one-to-one meetings, each side had to present his latest results. They then jointly discussed the progress report and prepared for the next meeting. If there were some changes that had to be made in the project plan, the counsels had to meet separately and decide whether or not to make them. In between the video conferences and the face-to-face meetings, other communication was taking place by telephone and emails, conducted mainly by the formalisation group representative.

5.3.7.2 Coordination of activities with the ORA strategic partners

During the execution of the ORA project, the team members had to follow standard operating procedures which had been established by Company-B to coordinate activities with the project partners. However, it was often mentioned that the coordination of activities was not as easy a task as the ORA team thought in the beginning of the project. Some of the reasons given for this were:

i. Three totally different sub-projects, which were conducted successively and involved different partners. Moreover, the long development cycle time made it difficult for the up and down streams partners along the development process to know about each other's capabilities.
ii. The high complexity of activities to be executed by different partners. It was difficult for the ORA development team to follow and understand the development process of these activities. Instead of overlapping their activities, the ORA team waited for the partner to get the final output then started their next activity.
iii. The high uncertainty in the output of each single activity. This uncertainty made the development team unwilling to know about others' activities until their work had been done "why should we bother ourselves if we are not certain about the output of others' efforts?"

The above factors were the main reasons for not overlapping the development activities with three project partners; Evotec, Amard, or Alkermes. However, there was very limited repetitive or rework of activities. As a result, there were no waste of time and resources due to the rework. In addition, the transition of output from one partner to another was generally smooth and well prepared. To a large extent, this limited rework was due to the control over the project that was imposed by the top management. The top management spent, on monthly basis, a moderate amount of their time and efforts in monitoring and controlling the development activities of ORA project. This is because the number of activities had to be executed monthly was very low. In addition, the unit-time to execute the activities was long.

In terms of the project plan, the ORA project team shared the development project plans with the strategic partners, so that every one involved in the project knew what were the milestones, what would be the consequence of any possible delay, and who was responsible. The partners also shared some IT tools, such as the Microsoft (MS) project management software and database.

5.3.8 ORA project performance

Much uncertainty existed in evaluating the ORA project at the time of the approval of its funding. Decisions regarding budgets had to be made on the basis of estimates of many critical pieces of information such as expected benefits, investment required, probabilities of achieving technical and commercial success within the desired time frame, etc. These estimates had to be made at a time when not much was known, and that available information was generally of low quality. Due to these reasons, the project plan did not include exact figures about the cost and time of the ORA development project. Rather, there was an estimated range of figures, minimum and maximum time and cost of development. The estimations were based on years of experience that Company-B has in the industry. Generally speaking, in the biotech industry, the development cycle time (schedule) is more important than the cost of development. Some managers even said that the cost was not the main issue. Company-B considers the development projects successful if the projects meet the estimated development time. Indeed, the company which registers its intellectual property (IP) first will receive all the advantages. This is because patent policies protect the company’s product, which means no other competitor can develop the same product within a certain period of time (17 years). That is why the one who registered his product first will receive all the benefits. The project team used a Gantt chart for project planning and controlling the development project.

The quality in the biotech industry means the safety of the product. It is not a question of good or bad quality, but rather, a question of how much safer and more effective the product is in comparison to other products in the market. If the molecule is safe and effective and has minimum side effects then the quality is considered good. This product should be able to provide a good ROI for Company-B.

In biotech industry, the issue of what is an acceptable delay is difficult to generalise as it depends on the specific competitive environment for the compound. For some products being two months late can be critical if it allows a competitor to launch first or if generics hit the market before Company-B can launch. For other products where there is less competitive pressure Company-B may chose to delay the launch to ensure the best pricing or to hit the right season (e.g. for allergies, flu etc). With respect to cost overrun, this is normally less important than time unless the additional cost is very high. Again it depends on the product and the sales potential. For a small product (<50 US$ million per year at peak) then a cost overrun of 10 US$ million would be considered poor whilst for a blockbuster with > $1 billion sales per year then a cost overrun of $100 million may not be too bad if delivered on time. There is always a trade-off between cost and time.

Because of the lack of clear figures of cost and time in the ORA development project, measuring the development performance was not an easy task. The project manager relies on his own experience to know if the project was on track or not. This explains why Company-B insists on hiring experienced project mangers.

In the ORA project, within the sub-project which has been taken as a case study, the development team was not able to meet the schedule and cost targets. The project had a delay and as a consequence was over cost (generally speaking, the cost in biotech projects are a function of time, the longer the development time, the more the project costs). The delay in the ORA development project was about 11 % more than planned (maximum planned time), and the cost was about 13 % above the plan. However, based on Company-B NPD projects, these figures considered within the acceptable limits, and the project considered a successful one.

5.4 Company-C Case Study

With over thirty companies around the globe, the group forms the most efficient organization serving the worldwide solid board, corrugated board and flexible materials industries. Company-C Group aims to help its customers with the differentiation of their businesses and the diversification of their products and services.

5.4.1 Company background

COMPANY-C, CHAMPLAIN, APOLLO, STEUER, ASITRADE, MARTIN, RAPIDEX, SCHIAVI, ROTOMEC, ATLAS, GENERAL, MIDI & TITAN along with its strategic partner BHS - design, develop, and manufacture their own products. In addition to Switzerland, France, Italy, England and Germany, manufacturing and assembly are also performed at the Group's facilities in Brazil, China and India.

The Group is formed of companies which complement each other. Its partners share their know-how when seeking quality solutions which enable purchasers to realize the best return on their invested capital. In the year 2004, there were 5812 employees (Figure 5-14). In 2004, the Company-C Group has reached a turnover of CHF 1.709bn (CHF 1.409bn in 2003) representing an increase of CHF 300m or 21.2% compared with the previous year (Figure 5-15).

5.4.1.1 History and development of Company-C

Created by Joseph Company-C (1862 – 1935), in Lausanne, Switzerland, as a supplier to the graphic arts industry, Company-C SA has specialised, under the leadership of Henri Company-C (1897-1975), in the development, the manufacturing, the sale and the service of machines dedicated to the printing, die-cutting, folding and gluing of flat and corrugated board. The company has been able to grow based on the original solutions its engineers were able to design. Each generation has applied the founders' will in a constant research for products adapted to the needs of the market, and achieved according to strict quality requirements, without technical compromises. The range of Company-C products is broad and complete. The experience gained thanks to the continuity of its founding concept allows it to expand the boundaries of the productivity of a packaging manufacturing plant.

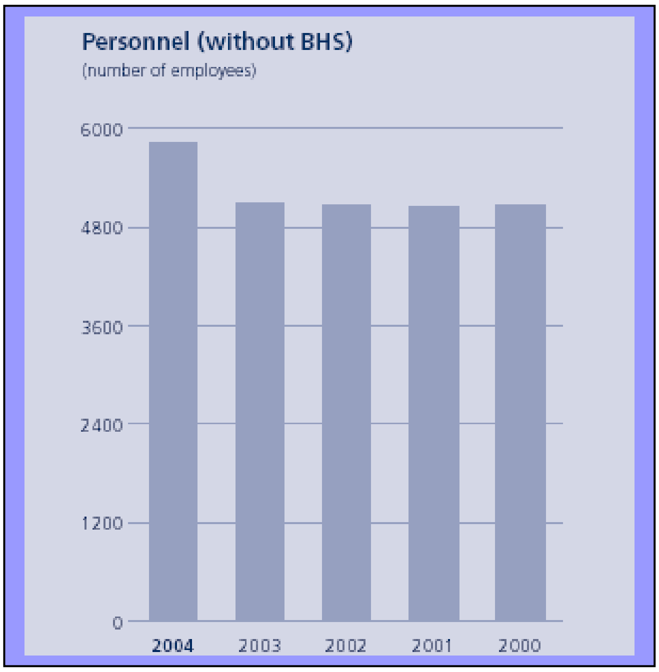

Figure 5-14: Total number of personnel from 2000 to 2004
(Adapted from: Company-C annual report 2001, 2002, 2003, 2004 and 2005)

Figure 5-15: Consolidate turnover from 2000 to 2004
(Adapted from: Company-C annual report 2001, 2002, 2003, 2004 and 2005)

5.4.1.2 Company milestones

Company-C milestones from 1890 to 2004 are shown in Table 5-6.

Table 5-6: The company milestones from 1890 to 2004
(Adapted from: Company-C annual report 2001, 2002, 2003, 2004 and 2005)

Year	Description of events
1890	Company-C opened a printing supplies shop in Lausanne (Switzerland).
1908	Opening of a workshop for customer service.
1915	Production of the first equipment.
1917	Company-C is registered as a trademark.
1918	A joint-stock company is formed under the name J. Company-C & Fils SA.
1938	Up-scaling to industrial production with the inauguration of the Prilly /Lausanne works (Suisse).
1940	The first *Autoplaten®* die-cutter is unveiled.
1965	Acquisition of Champlain (1938) in Roseland/NJ (USA).
1977	Beginning of the expansion with the Mex/ Lausanne site (Switzerland).
1978	The company is renamed Company-C S.A. and listed on the Lausanne Stock Exchange for the first time.
1980	Operations begin at a factory in Maua (Brazil).
1985	Acquisition of Martin (1923) in Villeurbanne and Bron/Lyon (France). Acquisition of Peters Maschinenfabrik GmbH (1890) in Hamburg (Germany).
1987	Acquisition of a shareholding in Schiavi SpA (1927) at Piacenza and Modena (Italy).
1990	Celebration of the centenary under the motto "Of Knowledge and People".
1993	Equity investments in Asitrade AG (1975) in Grenchen (Switzerland).
1997	Operations begin at a factory in Itatiba (Brazil). Operations begin at a factory in Shanghai (China).
1998	Acquisition of Corrugating Roll Corporation (CRC) (1971) in Rutledge/TN (USA).
2000	Takeover of Fairfield Enterprises Ltd in Redditch (UK), owner notably of Oscar Friedheim Ltd (1913), Company-C agent for sales and services in the United Kingdom and Ireland. Strategic partnership agreement with BHS Corrugated Maschinen- und Anlagenbau GmbH in Weiherhammer (Germany), involving the transfer of some of Peters' activities as well as the cession of CRC. Majority shareholding in Schiavi SpA (Italy).
2001	Adoption of a new legal structure. Company-C SA henceforth focuses on the development, production and marketing of its products and services. Shareholding management is provided by Company-C Group SA. Expansion of the factory in Shanghai (China). Expansion of the factory in Itatiba (Brazil).
2002	Implementation of an operational organization by business areas. Construction of a factory in Pune (India).
2003	Martin acquires Rapidex (1917) in Angers (France). Martin expands the factory in Bron/Lyon (France). Acquisition of the remaining Schiavi shares.
2004	Acquisition of the converting business of Metso Corporation (Finland), consisting of 6 partners : Apollo, Atlas, General, Midi, Rotomec and Titan. Majority shareholding in Steuer GmbH Printing Technology in Leinfelden (Germany).

5.4.2 Business overview

The worldwide service and sales network of the Company-C is composed by numerous companies and exclusive representatives around the world. These local companies maintain solid, close relationships with all members of the Group and strengthen their position with regional training and demonstration centres.

With the objective to satisfy their customers, the Group companies make every attempt to establish close relationships with them. The range of the products and services offered demonstrates their willingness to find a solution to almost any situation. Products that deliver what is promised, supported by training and productivity improvement programs, allow the purchasers to add value to their production, anywhere in the world, whenever they want.

5.4.2.1 Vision and strategy

The Company-C's strategy, the decisions resulting from it and their implementation are all based on a vision decided by the Board of Directors and Executive Committee several years ago. This vision is summarised by what Company-C terms that "3x3".

The fist "3" expresses the fact that the company want to be, and/or to become, the major supplier to the three main packaging sectors, which are the Folding Carton, Corrugated Board and Flexible Materials industries. Operations in these three sectors fluctuate somewhat differently over time and allow Company-C to be less dependent on their specific individual business cycles. At the same time, this permits the company to be active simultaneously in the markets of the three major packaging means covering the consumer goods economy.

The second "3" describes the intention of Company-C to be strongly present in the three global geographical regions which are Europe (in the broad sense of the term), the Americas and Asia. In the other words, it indicates Company-C Group's ambition to be a global player.

This vision has resulted in a long-term strategy oriented toward increasing the value of the company by focused investments and operational excellence throughout its expansion. Early in its history, Company-C identified its two main assets: the good reputation it enjoys in the market and the now-how of its personnel. Therefore, the company's investments are mainly directed towards product innovation and the training of personnel. This approach has enabled the company to provide its customers with the best performance/price ration available in the industries served. The extensive sales and services network throughout the world makes it possible to bring Company-C's products and services close to the customers, respecting the specific needs of each local market.

5.4.3 Company-C organisation and management

Company-C has a light organisation structure, very open environment, and little formalised processes. There is no separation between the top management and the other people down in the hierarchy. The top management encourage people to talk to each other. Managers meet and discuss informally with the technicians. In fact, this may lead to some conflicts, as the managers of these technicians may not feel comfortable with direct contact between their employees and the top management.

Company-C Company is almost a flat organisation. There are no many management layers separate between the employees and the mangers, or between the project manager and the CEO. This enables people from different levels to meet, speak, and exchange ideas and experience freely._The information is exchanged easily and smoothly between the people inside the company despite their position in the hierarchy.

There is story Company-C's employees like to tell. It is a bout a journalist who asked the CEO, few years back, if it would be possible to get the organisational structure diagram, which shows the hierarchy of decisions at Company-C. The CEO said, yes it would be possible if we had one!

Over years, Company-C group moved from being very rigid and formalised company toward flexible and informalised company. In doing so, the company was re-structured. The new structure is based on business units and product lines, where the engineers have more knowledge and know-how than the top management about the products and their development. This structure enable the product development projects members to be involved in decisions related to investments to be made in the development projects, and determine their own workflow and order of tasks. In the project lines, there is no comprehensive rules exist for all routine procedures and operations with regard to the development processes. Rather, the actual job duties are shaped more by the development project team members than by a specific job description.

The top management also do understand and support the fact that the engineers have the right to do mistakes sometimes. This encourages the engineers to innovate and develop new ideas and have some risky solutions to solve problem they face. This reflects the confidence that the company has in its employees.

5.4.3.1 Company-C structure

The organisation structure of Company-C is designed to be very flexible and lean as much as possible. It has been created to support the policy of the company, which is encouraging people at all levels to speak with each other and sharing knowledge and experience. In doing so, the company tried to remove any possible barriers that may avoid this contact.

At the beginning of 2002, Company-C introduced a new organizational structure focussed around three Business Units (BU): folding carton, corrugated board and flexible materials. This organisational structure is shown in Figure 5-16.

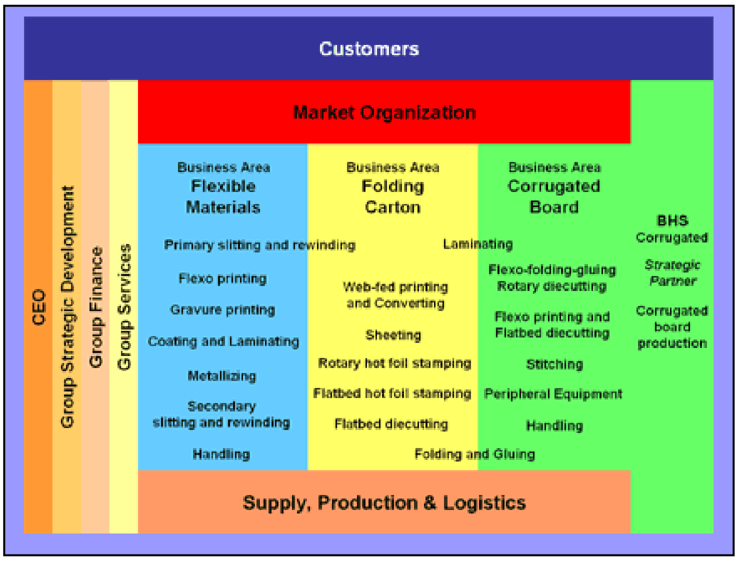

Figure 5-16: Company-C organisational structure
(Source: Company-C website)

These three business units draw support, on one hand, from the units responsible for production and logistics and, on the other hand, from a market organisation structured in terms of geographic zones encompassing the Group's sales and service companies around the world. For their part, the support services are responsible for various intersecting activities such as the coordination of R&D, strategic development or the finances of the Group.

Company-C has always distinguished itself by the performance of its products and services. The new structure ensures that its customers can take advantage of the synergies resulting from bringing the product lines together in order to achieve comprehensive solutions in packaging production. The long-term strategy of the Group is certainly based not only on the concept of equipment but also of services.

5.4.3.2 Business units

As mentioned up, there are three main business Units **(**BUs**)**: Folding Carton (which is the oldest BU), Corrugated Board, and Flexible Materials. Those three BUs consist of about 15 product lines **(**PL**)**. Each PL has its product-line strategy group (PLSG). The PLSG consist of three to four people: PL manager, R&D manager for the PL, service manager, and Sales manager for commercial and marketing (some times the PL manager is the Sales manager too). This group is responsible for the strategy of the PL and finding new ideas and making propositions for improving and development of their PL. Under each product line, there are some development projects. Figure 5-17 shows the business units, and the five product lines which are conducted by the Folding Carton business unit. In the following sections, I detail the folding carton business unit, as the NPD project, which will be presented later, belong to this business unit.

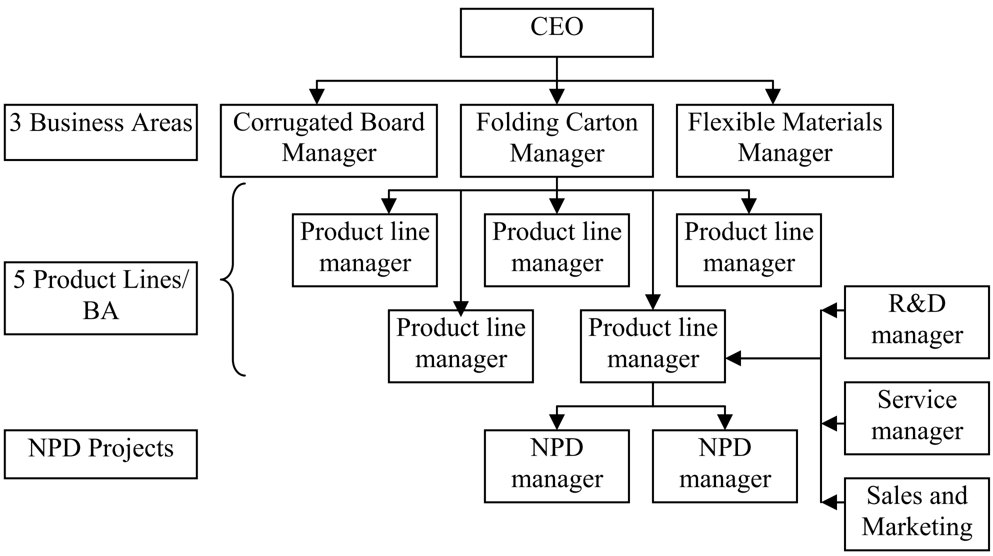

Figure 5-17: The three business units and product lines of the Folding Carton

Folding Carton

MARKET EVOLUTION

2004 saw a slight degree of growth in world consumer consumption, resulting in increased use of Company-C customers' converting capacity. Led by activity on the North American continent, companies in the developed countries regained confidence and increased their investment in modern machinery aimed at improving their profitability. The goods supply chain is continuously experimenting with cost reductions at every step of the process, including the cost of packaging. Customers particularly appreciate the numerous innovations which Company-C introduced at the international Drupa print media trade fair in Dusseldorf, Germany, as all of these contribute to lowering their manufacturing costs.

PRODUCT RANGE EVOLUTION

A brand new range of flat-bed die-cutters was launched at Drupa as a world premiere. The SPeria, entry-level press manufactured by Company-C in Brazil, addresses the needs of customers who are building their capacity. The innovative SPanthera is a mid-range model that allows all kinds of materials, from cardboard to plastic, to be converted at a very competitive speed. The elite SPrintera completes the range, offering the highest level of speed and productivity available anywhere in the world. Thanks to proven high-tech solutions, these machines handle the full range of materials to be die-cut with more flexibility and efficiency than ever before. In order to complement the offering to the Folding Carton market, the Apollo sheeters are now successfully distributed worldwide.

Since early 2004, Company-C has offered the most comprehensive range of solutions available for enhancing luxury packaging with metallized surfaces. Applications are centred around cosmetics, tobacco and liquor packages and labels, but also involve holograms used for bank notes and for anti-counterfeiting measures. The well-known Company-C flatbed stampers have been complemented by the new Steuer Foiljet, a high productivity rotary hot foil application machine. To achieve this, a majority share in Steuer GmbH company in Stuttgart was acquired and integrated into the Company-C Group Folding Carton organization.

2004 was very active on the foldergluers' side, with Company-C introducing the cost-effective Fuego and Mistral lines to the world market. Their versatility, performance and ease-of-use provide a perfect fit for Company-C customers' needs and should be accepted by most folding carton plants. Manufactured by Company-C at its Shanghai plant in China, the machines have scored a worldwide success. The release early in the year of the Alpina II folder-gluer as a successor to the renowned Alpina has also been very well received by customers looking for unique capabilities in terms of speed and short set-up times.

Champlain brought the Riviera printing unit to the market in 2004 as a major development in gravure printing technology. It successfully addresses critical points in the mass production of folding cartons, namely speed, reduced downtime, shorter set-up times and less waste. Used in conjunction with a Champlain flat-bed or rotary die-cutter, the Lemanic Riviera printing line represents the type of high-performance machine required for long production runs, such as in tobacco, food and healthcare applications.

Continual pressure from the consumer market demands greater added value with more differentiating features. The new Qualifier from Champlain closes the quality inspection cycle. With a minimum amount of human intervention, it automatically inspects packages to identify printing defects and reject unacceptable ones.

5.4.3.3 Research and Development

The R&D teams include in their development the fundamentals of reliability and productivity, without any technical compromise. The industrialisation of the product line has taken into consideration from the beginning the maximisation of production. The effort is made on the standardisation of elements in order to use them on a wide basis, as well as on the modular design of equipment common to families of machines. The measure of quality, its documentation and certification is a reality from one end of the range to the other.

Cost reduction without compromising the quality standards which have made the reputation of Company-C, is a constant concern. Manufacturing has been organised consequently. Quality controls are carried out at every step of the manufacturing and assembly of the machines.

The R&D at Company-C is focused on three major criteria:

i. New products based upon mastered principles and technologies,
ii. Modernisation and maintenance of existing equipment,
iii. Reinforcement and understanding of applied technologies and research for new knowledge.

An important share of the turnover, compared to other companies supplying industrial goods, is assigned to research and development yearly. These means grant the creation and the utilisation of a vast innovating potential. Multi-disciplinary teams were organised for each product. The emphasis is stressed on the gains in reliability and productivity, with the help of the most secure technologies. Each step of the development is optimised.

The fact that every step in the chain, from design to manufacturing, is realised under the same roof allows for the development in such a way as to reduce costs. Each machine, in the prototype condition, undergoes deep analysis. This is facilitated with the help of measuring equipment specially dedicated to fields such as vibrations, automatic settings, resistance of the materials, sound levels, and increases significantly the reliability of the products.

The development of modernisation and maintenance programs are applied to the Group's high quality that have been installed in the past. To keep them profitable, a permanent update of their performance is indispensable. The programs must benefit from the application of the latest techniques. The need for services is thus reinforced with adaptations and improvements at the customers' plants.

5.4.4 General NPD process model at Company-C

In 1998, Company-C launched its product development process improvement (PDPI) program, a large-scale analysis of Company-C's research and development activities. The results of the program made it possible to begin dividing development initiatives into several phases, each composed of clearly identified activities. For a project to enter a subsequent phase, it must first pass a quality control "gate" put in place to ensure the strength and success of the initiative. The PDPI's first emphasis was on time-to-market improvement and R&D efficiency, while working to ensure and yet improve product quality. During the final stages, numerous aspects linked to sustainable development were taken into consideration by the researchers. It seemed unconceivable to design machines with a long-term product life without awareness of the environmental impact of its products.

The PDPI is now being launched at each of Company-C's development sites. The process is anything but static and is undergoing continuous improvements, with environmental aspects taking on an increasingly important role.

Changes introduced by R&D are helping to alert designers to the choices available concerning materials and other components of the machines. Moreover, questions regarding industrialisation and production are now dealt with at an earlier stage than in the past.

The NPD cycle time depends largely on the size of the product, that is, whether it's a small or big machine. The NPD cycle time takes on average between 3 to 4 years for large machines. As shown in Figure 5-17, the organisation of Company-C is built around business units (BUs) and product lines (PLs). This indicates that the company is very much project oriented.

At the top there are four groups: GEC (General Executive Committee), Strategy development, financial, and service (including the technology manager) groups. Those groups do not participate directly in the PL's projects, but no project can take place without the support of those groups. Those groups provide full support and services to all the NPD projects in all PLs. For example, in each PL, there is R&D, but this R&D may sometimes need support from service group. Another example may be the team which develops the control of the products (hardware or software), and motion control, etc. This team is part of support and service group, but any NPD project normally needs help from this team. Therefore, this team is available to help all the NPD projects in all the PLs. The team is specialised and provides help to each area, and normally the NPD projects need it for very limited period of time (such as infinite elements calculation). The members of this team move from one project to another. They work on the project until they are finished with their job, then go on to another project. As shown in Figure 5-18, the NPD process model that has been adopted by Company-C consists of seven phases and seven gates.

5.4.4.1 Idea selection and opportunity review

Phase 0, gate 1, phase 1, and gate 2 are more related to ideas generation and marketing studies and are not very structured. These two phases are more internal processes and have been called at Company-C the "internal kitchen" of the product line (PL).

The product-line strategy group (PLSG) in each product line (PL) (the PLSG consist of: PL manager, R&D manager for the PL, service manager, and sales manager, some times the PL manager is the Sales manager) is responsible for the strategy of the PL, finding new ideas, conducting market studies, and making propositions for the improvement and development of their PL. Basically, new ideas come from this group, with inputs from others or outsiders such as customers, marketing people, engineers, or customer service. In some cases, new technology allows solutions that were not possible before and leads to new ideas.

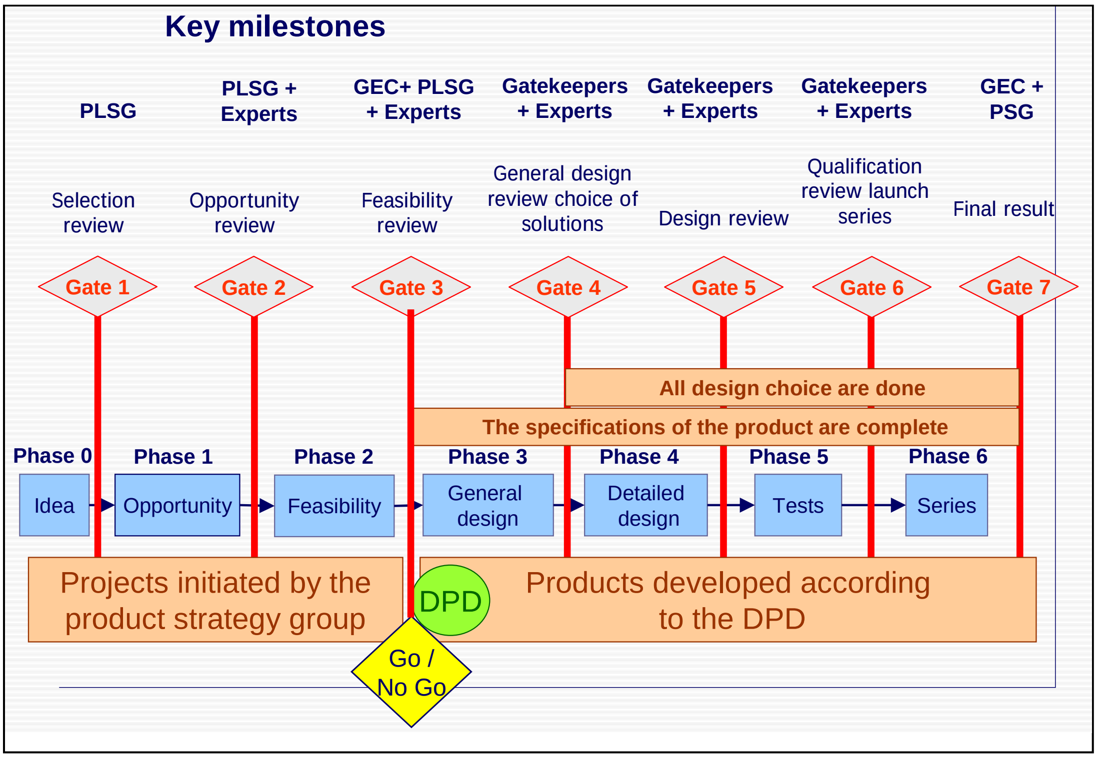

Figure 5-18: General NPD process model

5.4.4.2 Feasibility review

In phase 2, the PLSG group makes some technical analysis and allocates the team who will be responsible for developing the product concept. This team works jointly with the PLSG and R&D representatives to develop more then one proposal. Some strategic partners may be involved in this phase too. At the end of this phase, and before presenting the proposals to the gate keeper at gate 3, there is information that has to be ready such as: the cost of project, the total cost of development, the cost of the machine, clarification of risk, technology to be used (this is very important in case the technology is not mastered by Company-C), the performance, and the product specifications.

Gate 3 is considered the most important gate as the choice of the most efficient proposal and solutions will be made here. In Gate 3, the decision to accept proposals has to be made by the GEC (General Executive Committee). The GEC consists of the CEO, the three BUs managers, the Company-C's General Strategy Director, the Chief Financial Officer (CFO), Company-C Supply and Production Directors, and the Market Organisation Director, in addition to the Development Planning Director (DPD). The DPD is responsible for allocating the required resources for all the new projects in the three BUs. The DPD has to be sure that there are enough resources for developing the new project. Also, the DPD may coordinate the activities and expertise required for this project with the other PLs in other BUs.

If the GEC is convinced that the project has potential, a green light will be given to the PLSG to go ahead and develop the new concept. When the PLSG passes gate 3, it means the real development works starts. Roughly, it takes about one year from phase 0 to receive the green light at gate 3, and it costs about 5-10% of the total product development project cost.

5.4.4.3 General design

When the PLSG gets the green light at gate 3 to develop the project, phase 3, which is called general design, starts. In this phase, the NPD project team will assume all the responsibility for the project. All the technical choices have to be made by the team. For example, if, during the feasibility study, the PLSG investigated two or three potential solutions, the final choice has to be made in phase 3.

In Gate 4, the justifications for this selection have to be presented to the PLSG. The team has to explain why they selected this specific solution and not another. This gate is called general design review and choice of solutions.

5.4.4.4 Design review

In phase 4, all the detailed design and specifications have to be made. This includes all the detailed work which is necessary to manufacturing the pieces of the machine in addition to the software development. The decision about the design review has to be made at gate 5. Indeed, gates 3 to 5 represent the most important part of the development process at Company-C, as all the feasibility and complete design reviews are done in these phases.

5.4.4.5 Qualification review and launch series

Phase 5 is about industrialisation. At this point, the NPD team develops and assembles the prototype. The prototype is the first machine which is developed for testing (performance, reliability, max speed, max load, etc.). Once that has been done, the team goes to gate 6. In gate 6, a qualification review is made. The gatekeepers and the experts give the green light for series manufacturing.

5.4.4.6 Final result

In phase 6, the NPD project team starts the series industrialisation and optimisation of manufacturing.

At gate 7, the final review is made. In this phase, a few of the machines should be in the field for couple of months for testing and verifying the final machine. A positive result of this gate will result in the order for mass production.

5.4.5 The Mistral product development project

Under the Folding Carton Business Unit, there are three product lines (PL). Within each PL, there are some development projects. The project which has been taken as a case study is under the PCR product line, and named MISTRAL.

The goal of the project is to develop two machines, named Mistral and Fuego. The machine is shown in Figure 5-19. Those two machines have similar development processes. The difference is in the quality of performance. Mistral has better, that is, faster performance than Fuego. I will only focus here on the Mistral machine.

5.4.5.1 Introduction to the PCR product line

As a manufacturer of folder-gluers since 1942, with the PCR 382, Company-C can claim considerable experience in this field. The know-how gathered during these long years has enabled the design of folder-gluers meant for flexibility, ease of operation and high productivity.

Figure 5-19: The Mistral machine
(Source: Company-C website)

Short runs, increasingly complex boxes, precision required by automatic packaging and conditioning machines together with the gain in productivity have marked the evolution of these products. These ranges of products whose reliability has been recognized by the industry meet these exacting requirements.

The latest technologies have been applied so that packaging manufacturers can receive the maximum benefit from modularly designed lines. Each machine exists in several versions and varieties according to the degree of automation and the different types of boxes to be produced. Integrated quality control devices ensure the monitoring of the boxes conformity, uniformity and quality.

The last generation of folder-gluers has established a new standard in the industry. It produces a great variety of boxes in a wide range of sizes, at unbeatable production speeds and with remarkable quality. An example of the latest generation of these machines is the Mistral product (machine).

5.4.5.2 Mistral project characteristics

This high-tech project was one for which the technological complexities were considerable. Mechanical, electrical, and soft and hardware technologies had to be integrated. In terms of component parts and features, the machine was based predominantly on new technological development.

The development time of this project was three and a half years. The average number of activities was approximately two to three per month. The majority of tasks were carried out sequentially. However, some were carried out in parallel. The average ‘unit time’ to execute a task in the Mistral project ranged from two weeks to a month.

5.4.5.3 The development process of the Mistral machine

The total development cycle time of the project was about three and one-half years, starting on April, 2001 and completed on October/November, 2004. The first machine was developed at Company-C-Switzerland, then the assembly and mass production was done in Company-C-Shanghai site, in China.

Generally, the project followed the company's established product development process model shown in Figure 5-18. The market input was the most important issue in the first three phases (0, 1, and 2), until gate 3. This input came from the marketing, sales, customer service staff, and the project's partners. On the other hand, from gate 3 to gate 7, what really mattered was the technical input that came from the engineering and technical staff, and the project partners.

Project manager and his committee

Once the Company-C Company approved the Mistral project concept, gate 3, a project manager was assigned to lead the project. Since then, the rest of the development process was his responsibility. He took all the decisions related to type and brand of new equipment would be purchased, training method to be used for the project team. In addition, he made all decisions related to the appointment of the project team members and created what was known at Company-C as the project committee (cross functional development team leaders). This team consisted of electrical, mechanical, software and electronic functional leaders. Each functional leader was responsible for certain phases in the project related to his function. Unlike the project development team, the project manager and the project committee were permanent and responsible for the entire project, from concept development, feasibility study, up to bringing the new product to the market and launching the first machine.

During the phases of the project, the project manager and his committee discussed all the problems and challenges they were facing, and decisions have been taken based on these discussions. The power of the project manager was clear in the decisions he was able to make. The project manager decided what type and brand of new equipment to be bought for the project, and which training method to be used for the project team.

Project team

The number of people contributing to the project was ranging from 65 to 130, representing different functions, such as electrical, mechanical, software, hardware and electronics engineers. The team was partially changing, based on the needs of each phase. In some phases the number of workers was much higher than in other phases. It all depended on the activities to be executed in each phase. Some experts from other functions participated in solving very detailed technical problems. Once the problem was solved, they left the project. This was also the case with the sales and marketing people. They provided the project team with the market needs. Once the needs had been specified, they returned to their normal functions. The permanent project team, who participated in all project phases, was able to make most of technical choices and select methods of execution without being told by the top management.

Figure 5-20, presents an overview of the duration of the different activities in the Mistral development project and the number of people who were carrying out these activities.

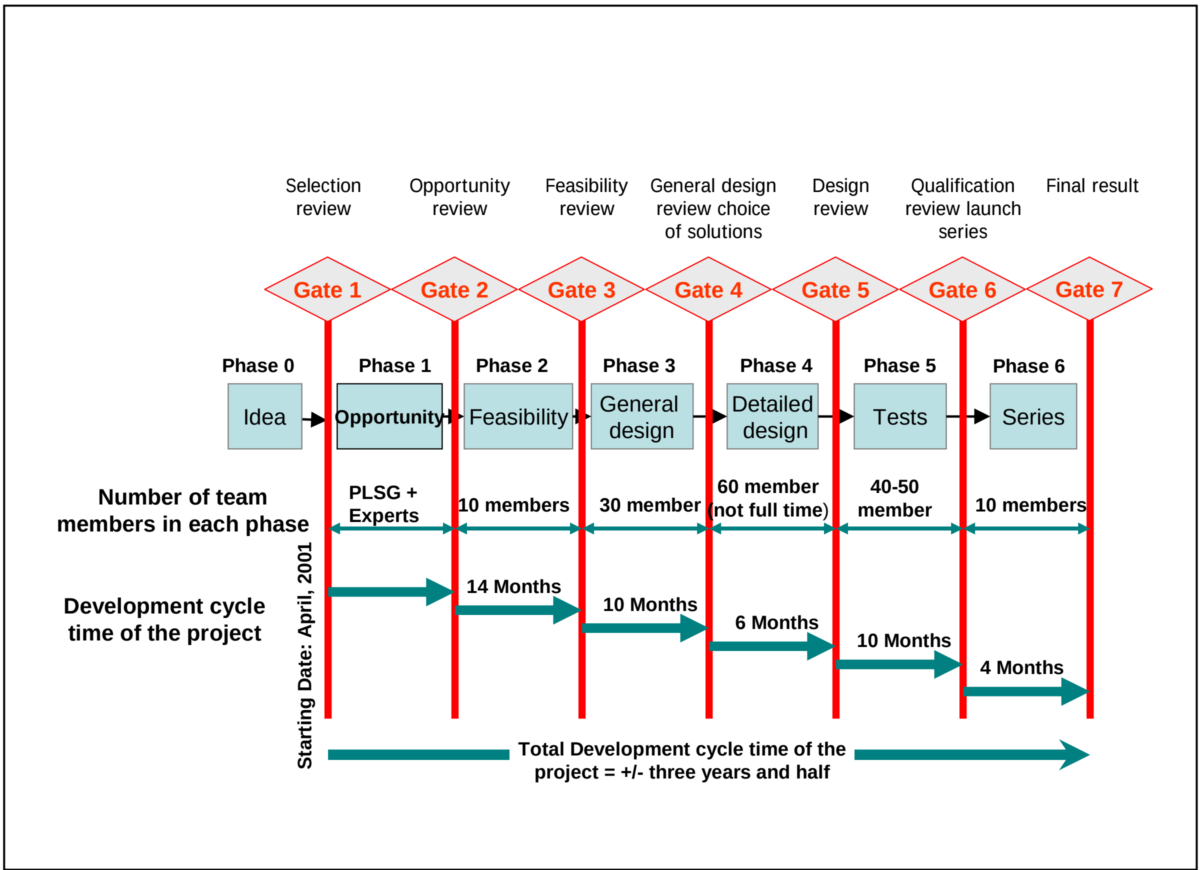

Figure 5-20: Time and number of team members for the development of the project

Project planning and controlling

In the planning phase, the project manager discussed the time and cost of each activity in the project with the project committee (functional leaders), so that they could set up a complete plan for the project.

To keep the project on track, there were some indicators that were fixed to control the project performance in terms of cost and time of development (operational cost and time). In doing so, the project management used a project system called PSN8, which was based on the critical path method (CPM).

In the CPM, the project manager and his committee assumed that the estimated completion time for the project could be shortened by applying additional resources – labour, equipment, capital – to particular key activities. It assumed that the time to perform any activity is variable, depending on the amount of effort or resources applied to it. As for technical work, the team management uses the phase-gate, shown in Figure 5-18**,** to control the technical activities. There were weekly meetings between the project manager, his committee and the partners' engineers who were involved in the activity in progress.

5.4.6 Mistral project strategic partner

Company-C works closely with its suppliers to improve their products and services, which in turn would improve the products and services of Company-C it self. This is the reason why Company-C always asks for an exclusive relationship with its strategic suppliers. In order to secure its business and to keep its competitiveness in the market, Company-C tries to have equity investments in its important partners. The investments range from 30% as the case with BHS to 75% as with Asitrade. Moreover, as shown in Table 5-6, throughout its business life, Company-C have acquired several companies. Group of partners participate in a product lines. Each single partner is a company with a separate organisation, and independent management and development team and manufacturing facilities. This is also the case with the companies that Company-C had already acquired (e.g. Champlain). Currently, all these partners have complementary products. The reason for Company-C to partners with these companies is to supply all what the customers need. Company-C would like to provide a complete solution for the packaging industry. The size of those companies is different. In the following sections, the strategic partners are introduced.

5.4.6.1 BHS

For the production of corrugated board, BHS Corrugated offers all the individual components and machines required, from the reel stand to the stacker. BHS also offers complete corrugators, ranging from individual flexible sheet feeder concepts up to so-called volumgators for very high output capacity.

Since 2000, Company-C Group and BHS, which is a German company, have joined together their resources and competencies in the field of corrugators, corrugating cylinders and related field service activities. The supply of modern and reliable corrugators, at the highest level of technology, and the services which go with it, are the real strength of BHS. The company's Skilled and highly qualified employees participate in the mechanical and electronic development of full lines of remarkable reliability.

5.4.6.2 Asitrade

Under the Asitrade tradename machines for the manufacture of single-face microflute corrugated board are produced, as well as laminators which glue sheets of high-quality print onto single-face corrugated board.

Asitrade SA was founded in 1975, in Switzerland. It has been a partner of the Company-C since 1993. It is the leading supplier of equipment for litho-laminators and it has gained the reputation as a market leader with its production lines which form three groups of products:

i. Corrugators for the manufacturing of single-face corrugated board in web
ii. Laminators for the lamination of a pre-printed sheet or web on a single face web
iii. Solutions integrating the manufacturing of the single-face and the lamination of pre-printed sheets or webs.

The final output of an Asitrade line is a quality product with high added-value for a low price and combines the strength of corrugated board with good offset printing quality on solid board. Asitrade combines the dedication for innovation and a wealth of know-how. Their specialists develop suitable market orientated products, which contribute to the strong market position of Asitrade and its customers.

5.4.6.3 Champlain

Champlain offers web-fed production lines for the printing and the inline converting of folding carton. These lines serve the cigarette packaging, liquid carton and general folding carton industries.

Champlain has been a major player in the history of the inline production since its beginning. Its European roots combined with early North American experiences enabled it to benefit from the best of both worlds and to transform these skills into products which meet with markets needs since 1938 and still comply with today's customers' requirements.

Designed for adding the maximum amount of value in a single pass, Champlain production lines print and die cut cartons in a continuous process without interruption.

5.4.6.4 Martin

Martin was created in 1923 in Lyon, France, and partnered with COMPANY-C in 1985. The company, with its 800 employees, has a wealth of experience in the design, manufacture and sale of machines which combine printing, die-cutting and folding-gluing of corrugated board.

Under this trade name, machines are produced for the manufacture of corrugated cases incorporating printing, cutting and creasing, folding and gluing (or stitching). Other products include in-line rotary diecutters, which achieves the printing and converting of corrugated board in a single operation. Martin also supplies automatic feeders and palletizers for this material, as well as complete automatic handling systems for corrugated converters.

Table 5-7, present the Mistral project strategic partners. Within this list, Company-C has equity-based partnerships with BHS and Asitrade.

Table 5-7: Mistral project strategic partners

Project strategic partners	Type of relationship	Size (people)	Expertise
BHS	Equity-based partnership (minority holding)	Medium	Components and machines suppliers
Champlain	Acquisition (independent organisation and management)	Large	World leader in web-fed printing and inline converting solutions for the industries of tobacco, liquid cartons and general folding carton packaging. Web-fed production lines
Asitrade	Equity-based partnership (minority holding)	Medium	Leading supplier of equipment for litho-laminators and creative microflute solutions.
Martin	Acquisition (independent organisation and management)	Medium	Design, manufacture and sale of machines which combine printing, die-cutting and folding-gluing of corrugated board.

5.4.7 Integration process elements with the strategic partners

As with the previous two cases, in this section, I investigate the average intensity of communication and coordination between the Mistral project team of Company-C and the project strategic partners' teams, specifically, those in whom Company-C had equity investment: BHS and Asitrade.

In the Mistral development project, different communication and coordination means were used in different development phases.

5.4.7.1 Communication

In the early stages of the Mistral project, product design engineers informed the project strategic partners (BHS and Asitrade) team members who participated in the project about their activities without asking them to take direct action. The goal was to give downstream functions (partners' functions) clear background information about the project so that they (project partners' team members) would know what kind of work would eventually be coming up from them, and how their work would contribute to the project as a whole.

Communication with the BHS and Asitrade companies during the execution of Mistral development project was mainly limited to an interaction at the top levels of project management of both sides (Company-C and project partners). The project manager and his committee met face-to-face with the project partners on a quarterly basis. In some cases, project team members from both sides participated in these meetings too. The goal of these frequent meetings was to check the development progress and to discuss the emerging issues. Out of these face-to-face meetings, when there was a problem with a specific function, the project manager would ask for an urgent meeting with the suppliers. These urgent meetings were, in most cases, face-to-face, as that was the preferred communication means for the project manager and his committee. The face-to-face meetings were, to some extent, possible most of the time, because the project strategic partners were geographically close to each other (for instance, the Company-C development team was based in Lausanne, Switzerland, and the BHS was based in Germany, and Asitrade was based in Grenchen, Switzerland). However, when it was difficult to meet face to face, the development team used email and video conferences to communicate with each other. The flow of information among the project partners was good, as they were sharing the project plan, data, rising issues, and updated marketing studies.

Most of project related information and data was available to all the project members, either from Company-C or from its project partners who were participating in the project.

5.4.7.2 Coordination

Due to the fact that Company-C has invested in its partners – by buying shares of the partners' companies – the Mistral project team and their partners were able to share knowledge and important and sensitive data, such as market studies, databases, and the project plan. The NPD project team of Company-C and the project partners (HBS and Asitrade) created mutual product goals for this project. They jointly developed a Project Management Information System (PMIS). This system provided the means for monitoring the network of tasks – e.g. identification of tasks, resources requirements and costs, establishing priorities, planning and updating schedules, and measuring project performance. The monitoring function ensured that the management of Mistral project on both sides, Company-C and its partners, received reports in sufficient detail and frequency to enable them to identify and correct problems early. This helped in managing the interdependency between activities executed across the project partners.

However, the Mistral project was characterised by two types of dependency at work. The first was a conventional producer/consumer dependency between the work processes of Company-C's project team and the partners. In this dependency, both sides – due to the complexity of the development processes and engagement of the project partners' team in other development projects – faced some problems in managing the development process dependency. These problems resulted in some rework, which led to some delay. The second type of dependency was the activities, tasks, and sub-tasks hierarchy of dependencies in Company-C's part of the project. It was represented by the project plan and schedule of delivering the project on time. This part of the dependency was conducted as planned. The project management believe that they spent a moderate percentage of their working time and efforts in managing the tasks interdependency with the both HBS and Asitrade.

The project plan also served as a principal coordination mechanism at the Mistral project level. Both the Company-C team and their partners, BHS and Asitrade, shared production planning and operations, procurement, order processing, engineering changes and design. The sharing culture in Company-C project management resulted in improving customer service and fast response to environmental changes.

As show in Figure 5-20, the downstream activities were started after interdependent upstream activities had been completed. This is to say that the activities were carried out, mainly, sequentially, one leading to the next. There was limited overlap between activities carried out by Company-C and those carried out by the project partners, although each partner knew in advance what would be his contribution to the project.

Occasionally, experts from the project partners came to work at the Company-C site for a week or so. This occurred for the most part when the Company-C team needed to insert a part in their machine that had to be manufactured at the partner facility.

5.4.8 Mistral project performance

Generally, the development project at Company-C is considered successful if it meets the development plan, cost (the operational cost, which includes salaries, resources, etc), time (from the concept development to the market), and quality (functionality of the product).

Due to the high market uncertainty in this industry, the project management may cancel a development project, even if it is on schedule. Most of the time, a market change is the only reason to cancel a development project. It is very important for Company-C to check out the market on a frequent basis during the execution of development projects.

In the Mistral development project, the goals that were set were:

i. Financial, in terms of development cost, product cost and price.
ii. Time, in terms of due dates for certain development activities and stages to be completed, production ramp-up dates and production start-up dates.
iii. Quality, in terms of delivering to specifications and customer requirements, compliance with international standards and regulations and production quality.

These goals were set jointly by the project manager, project committee, and partners' representatives. During the execution of the project, the focus shifted from setting project goals to controlling them. When necessary, these goals would be adjusted during the course of a project, for example because a customer or the marketing department had changed their minds, or because new technologies had emerged. No procedures were in place to control these adjustments; they would be made whenever and in whatever way necessary.

The project development was delayed up to three months, which represented about 7% more than planned. This was because some functions were involved late in the project, especially those which needed to be executed by experts. The experts often took more time than initially scheduled to finish development activities because they were also engaged in other projects within Company-C itself. As a consequence of the project delays, the project was over cost by about 9%. On the other hand, the project team were able to meet all the product functionality which was set during the project planning phase.

5.5 Summary of the case studies

The following three tables summarised general data and information presented in the previous three case studies. Table 5-8 describes the three companies Company-A, Company-B, and Company-C. Table 5-9 describes the three NPD projects (io-Digital-Pen, ORA, and Mistral) which were carried out by these three companies. Finally, Table 5-10 presents the characteristics of these three projects.

Table 5-8: Companies' description

	Company-A	Company-B	Company-C
Size (no. of employee)	6'500	4'900	5'812
Founded	1981	1906	1890
Turnover	1.27bn (US$)	2.458bn (US$)	1.709bn (CHF)
Business field	Electronics	Biotechnology	Mechanics
No. of business units	4	5	3
Country of origin	Switzerland	Switzerland	Switzerland
Main headquarter	USA	Switzerland	Switzerland
National/International	International	International	International
Market competition	High	High	Medium
Technology changes	Rapid	Medium	Medium
Product life cycle	Short	Long	Medium
Profitability over the last three years	Increased	Increased	Increased

5.6 Conclusion

This chapter presented and described three high-tech companies conducting NPD projects with strategic partners. Although the three projects were developing different products, they (the development projects) were facing similar challenges in terms of uncertainty (e.g. in the product development processes output) and complexity (e.g. components development complexity with low modularity, and high geographical spread development teams from different partners).

In the next chapter the three cases studies will be discussed and analysed. Based on the case studies, the most important organisational attributes will be identified. Then, with the support of the literature review, the relationship between these attributes and the integration elements, and project performance will also be presented.

Table 5-9: NPD projects description

Attributes	io Digital (Company-A)	ORA (Company-B)	Mistral (Company-C)
Project phases	3	6	8
Project gates	2	5	7
Team organisation	Matrix	functional	Cross functional
Average team members[39] (of the network lead Co.)	20-25	45-65	60-130
Team responsibility	For the entire phases of the project	Different teams for different phases	Different teams for different phases
Project leader responsibility	For the entire project	Different leaders for different phases	For the entire project
Total number of project partners	6	7	3
Equity-based partnerships	3	3	2
Partner type	Technology and raw materials suppliers, and designers	Basic research and development	Supplier and manufacturer

Table 5-10: The three NPD projects characteristics

Project characteristics	io Digital (Company-A)	ORA (Company-B)	Mistral (Company-C)
Technological complexity	High	High	High
Newness of technology (in terms of component parts and features)	New	New	New
Variety of technologies used	High	High	High
Uncertainty of the output	Unpredictable output	Unpredictable output	Unpredictable output
Development Cycle time	Short (14 months)	Long (6 years)	Medium (3 years and half)
Average number of tasks executed monthly	High Two to three/week	Low	Medium Two to three/month
Average unit-time to execute tasks	Short (from few days to weeks)	Long	Medium (two to three per month)
Nature of tasks execution (parallel or/and sequentially)	In parallel and sequentially	Sequentially	Mainly sequentially and occasionally in parallel

[39] Who participated directly in the project

6 Findings

6.1 Introduction

This chapter presents the findings and examines the data collected from the three world-class organisations presented in the previous chapter. The findings are organised based on the preliminary model developed in chapter three (Figure 3-3). I examine first the three NPD projects' performance in terms of cost, time and quality. Second, I measure the integration process elements – communication and coordination – between the project team of the network lead company and the project strategic partners' teams. For these, I use measures developed in chapter 4. Third, after analysing the contents of the interviews, I identify the primary determined organisational attributes that have greatest impact on the integration process elements. Then, I aggressively apply the organisation theory literature to assess the level of each attribute –whether it is high, medium or low – in the three case studies.

6.2 The NPD project performance

The success NPD project was gauged according to the traditional criteria of cost, schedule, and technical performance. In all three projects, I investigate the following: Was the product developed within the budget? Was the project available to the customers on its targeted delivery date? Regarding quality, to what extent were the functional and reliability objectives attained? It bears pointing out that the three companies in this study are all profitable industry leaders. From each company, an NPD project (new to the company product), has been selected from the most profitable business unit.

Generally speaking, the development projects at *Company-A* are considered successful if the projects meet the cost, schedule, and performance (CSP) planned for the project. This is the case for most development projects. However, because 'development cost' is amortized over high volume for most devices, Company-A is less sensitive to this variable than it is to 'product cost.' Anything less than 20% over the planed development cost is not considered a big issue, especially for new-to-firm project, like io-Digital-Pen, while more than 5% over the product cost is thought to be considerable.

In the io-Digital-Pen project, the development team was not able to meet the schedule and cost targets. The project had a delay of up to six weeks, 10 % over the 14-month planned development time, and was approximately 14% over the anticipated cost. Both figures were considered small and within the accepted range of successful NPD projects at Company-A. However, the reasons behind the delay and cost over-run originated in different phases and had different root causes, as described below. For more information about the io-Digital-Pen project performance, please see section 5.2.8.1.

The first delay occurred during the development phase. One of the main reasons for the delay and cost over-runs in this phase was the inaccurate development cost estimation information provided in the early phase of the project by the project technology supplier. The Company-A io project team had no other recourse than to rely upon the accuracy of the cost estimation figures provided by the supplier, the source of the technology. This proved to be an unfortunate circumstance.

The second delay occurred during the beginning of the production phase. Specifically, there was a huge problem with the quality of the silicon supplier. This resulted in production stoppage as the team waited for specification improvement.

It is worthy to note that the two main reasons behind the project's delay and cost overage had nothing to do with the communication and coordination processes between the project partners. In other words, during the project execution there were no delays due to repetitive work, difficulty in output and input transitions, slowness in decision making, etc.

The *ORA project* of Company-B represents an industry where the development cycle time is very long (the entire development activities of ORA project might take up to twelve years). Much uncertainty existed in evaluating the ORA project at the time of the approval of its funding. Decisions regarding budgets had to be made on the basis of estimates of many critical pieces of information such as expected benefits, investment required, and probabilities of achieving technical and commercial success within the desired time frame. These estimates had to be made at a time when not much was known, and during which the available information was generally of low quality. Consequently, the project plan did not include exact figures about the cost and time of development. Rather, there were an estimated *minimum* and *maximum* development time and cost. The estimates were based on the experience that Company-B has in the industry. The ORA project plan described how the project would proceed, what had to be done, and how it was to be accomplished (e.g. type of tests and experiments, number of people to be tested, etc.).

Generally speaking, the development cycle time (time to market) in the biotech industry is more important than the cost of development. Some managers in Company-B even said that cost was not an issue. Company-B considers the development projects successful if the projects meet the estimated development time. Indeed, in this industry, the company that registers its intellectual property (IP) first will receive all the advantages. This is because patent policies protect the company's product, which means that no competitor can develop the same product within a certain period of time.

In the biotech industry, *quality* means the effectiveness, reliability, and safety of the product. It is not a question of good or bad quality, but rather, a question of how much safer, reliable, and more effective the product is in comparison to other products in the market. If the molecule is safe and effective and has minimum side effects, the quality is considered good. This product should be able to provide a good ROI for Company-B.

The project had a small percentage of delay and, as a consequence, was over budget. The delay in the ORA development project was about 11 % more than planned, and the cost was about 13 % above the plan. Both figures were within the acceptable limit at Company-B, and compared favourably to the development projects of other biotech companies. For more information about the ORA project performance, please see section 5.3.8.

In the Company-C *Mistral development project*, the performance goals were set jointly by the project manager, project committee, and partners' representatives. During the execution of the project, the focus shifted from setting project goals to controlling them. When necessary, these goals were adjusted during the course of a project, for reasons such as a change of mind on the part of a customer of the marketing department, or because new technologies had emerged.

The project development was delayed for three months, about 7% more than had been planned. This was because some functions were engaged late in the project, especially those that needed to be executed by experts. The experts often took more time than initially scheduled to finish development activities because they were also engaged in other projects within Company-C itself. As a consequence of these delays, the project was approximately 9% over budget. On the other hand, the project team was able to meet all the product functionality established during the project planning phase. For more information about the Mistral project performance, please see section 5.4.8.

The results of three NPD projects performance are shown in Table 6-1.

Table 6-1: The performance of the three NPD projects

Performance Criteria	Io Digital (Company-A)	ORA (Company-B)	Mistral (Company-C)
Development cost (% of over cost)	14%	13%	9%
Development time (% of delay)	10%	11%	7%
Quality:			
- Functional	High	High	Medium
- Reliability	Medium	High	High
The rate of overall performance:			
- Based on company performance criteria	Within the accepted limit	Within the accepted limit	Above the accepted limit

6.3 The integration process elements

The conceptual model presented in Chapter 3 proposed that the integrated NPD process was the result of communication and coordination between the project partners' teams. In this section, based on measures developed in Chapter 4, I measure the intensity of communication and coordination activities between the NPD project team of the network lead company and the project strategic partners, specifically, those in whom the network lead companies made equity investments. I investigate the average intensity of communication and coordination activities that occurred during the development of the project.

6.3.1 Actual communication with the NPD project partners

In this section I examine the actual intensity of two aspects of communication: frequency of communication, and the rate of flow of information and knowledge sharing, see table 4-1. Because they are frequently found to be interrelated, these won't be described independently. However, they will be examined separately.

In terms of the *io-Digital-Pen project*, there was very intensive communication between the partners – Anoto, Design-Partner, and A4Vision – during the concept identification and design phases. The *io-Digital-Pen* project team knew very well that they could not design a part or component of the product if it was not the core of their speciality, which meant that they had to request it from the supplier. Since they were not experts in the supplier's field of industry, it was impossible to make a clear request for a technical component or part necessary for the development of the digital pen product. To overcome this problem, the project team presented to the partners the concept of the new product and what was needed to develop the product. The combination of frequent interaction with the supplier and the ability to have their own point of view led the team to come up with the right component in the end. The idea was to benefit from the supplier's expertise in his own field. Indeed, this interactive way of working was important to the development of the *io-Digital-Pen* business case, presented in the beginning of the project to the NPD project committee for approval. The *io-Digital-Pen* project team would have been unable to estimate the time and cost of development or the quality of the product without the full engagement of the partners in developing the business case.

In order for the development team to obtain the right product from their partners, engineers from both sides had to work closely together to customize the product to meet market requirements and technical constraints. For an instance, to design the external shape of the io-Digital-Pen, the product development had to work closely with Design-Partner (an Irish company with which Company-A had worked closely since 1996). On the other hand, for the identification system of the digital pen, the product development team had to work with the A4Vision. The three companies made up a team whose collective goal was designing the product shape based on marketing requirements and engineering constraints. To accomplish this, the team had monthly face-to-face meetings, in addition to conference calls and email exchanges.

In the *io-Digital-Pen* project, 40% of the partners were new to Company-A company. Working with new partners was not as easy as working with a partner with whom Company-A had previous experience. Effort had to be put forth to build a good partnership. For example, Anoto, one of the technology suppliers was new to Company-A, and the two companies started working on this project with no prior experience working with each other. The individuals from the two companies spent some time just getting to know one other and understanding what every part meant when specific terminology or expressions were used (e.g., as process, qualification, verification, testing, etc). In that phase of the project, the goal of the project manager was to develop a common language with the partner's team. The two partners developed a common lexicon – a list of words with definitions – which proved very useful, especially in the beginning of the project, in helping to limit the sources of misunderstanding between them. This lexicon's positive impact was noticed by the entire *io-Digital-Pen* team in the weekly (the minimum level of communication between the two factions) video conferences. However, in addition to the videoconferences, there were face-to-face meetings held either in Sweden or Switzerland, for design review and technology development. These meetings took place every two months in the beginning of the project and during the design phase.

In addition to these means of communication, Company-A has adopted information technology and systems to improve the level of communication with Anoto, A4Vision, and Design Partners. Lotus-notes database and groupware were key tools in the *io-Digital-Pen* projects. These information systems enabled teams from different partners to communicate with each other, share documents, and generate custom workflow applications. In addition, Company-A and its strategic partners used Microsoft Project to manage the project. The io-Digital-Pen team also utilized chat rooms capabilities of services like Yahoo and MSN messenger to communicate on-line with the project partners.

This high frequency of communication and information flow between the Company-A *io-Digital-Pen* project team and the project strategic partners enabled the following: i) the project purpose, targets, and plan were well understood by all the teams participating in the project; ii) the information related to the project flowed freely among the teams, and iii) all channels of communication were open. This accelerated the decision making process; Partners upstream and downstream knew about each other's functions and capabilities; and finally, there was less conflict between project partners. For more information about the communication activities between io-Digital-Pen project team and the project partners, please see section 5.2.7.1.

At the Company-B *ORA project*, there was only one channel of communication with three strategic partners, Evotec, Amard, and Alkermes. The communication between the ORA project team and the project external partners was centralised and occurred mainly through a defined channel. The project manager appointed the formulation group representative to be responsible for the contact with the external partners. All communication between the Company-B's ORA project team and their partners had to be carried on through this channel.

Because the strategic partners' teams were geographically distributed across different European countries and the USA, it was difficult for the teams to meet face-to-face on a frequent basis. There was, therefore, a need for a communication medium and protocols to manage and control execution of the activities. Videoconferences seemed to be a good method for holding meetings. Some individuals participated on a regular basis in the videoconferences. These were the project manager and the representatives of the following functions: formulation, safety, and discovery. Each one discussed issues related to his function. These videoconferences took place every three months. Apart from these videoconferences, communication for controlling and monitoring the project progress was achieved by the formulation representative. During the development of the project, it was very rare that an informal contact occurred between the ORA project members and the project partners.

During the ORA project, the face-to-face meetings between Company-B and each partner, Evotec, Amard, and Alkermes were held two to three times a year. In these meetings, each side had to present its latest results. They then jointly discussed the progress report and prepared for the next meeting. If there were changes that had to be made in the project plan, the counsels had to meet separately and decide whether or not to make them. Between the video conferences and the face-to-face meetings, other communication was taking place by telephone and emails. For more information about communication activities between ORA project team of Company-B and project partners' teams, please see section 5.3.7.1.

In the early stages of the *Company-C Mistral project*, product design engineers informed the BHS and Asitrade team members about their activities without asking them to take direct action. The goal was to give downstream functions clear background information about the project so that they (project partners' team members) would know what kind of work would eventually be coming up from them, and how their work would contribute to the project as a whole.

Communication with BHS and Asitrade partners during the execution of Mistral development project was limited to an interaction at the top levels of project management. The project manager and his committee met face-to-face with the project partners on a quarterly basis. In some cases, project team members from both sides participated in these meetings too. The goal of these frequent meetings was to check the development progress and to discuss the emerging issues. When there was a problem with a specific function, the project manager would ask for a meeting with the suppliers, preferably face-to-face. This was generally feasible, due to the geographic proximity of the project partners. For example, the Company-C development team was based in Lausanne, Switzerland, the BHS was based in Germany, and Asitrade was based in Grenchen, Switzerland. However, when it was difficult to meet face to face, the development team used email and video conferences to communicate with each other.

The flow of information among the project partners was at an acceptable rate as they shared the project plan, technical and marketing data, emerging issues, and periodic reports. Most project related information and data were available to all the project members, either from Company-C or from its project partners. For more information, please see section 5.4.7.1.

Table 6-2, summarise the actual intensity of communication between the development team of the network lead company and the project strategic partners' teams in the three case studies.

Table 6-2: The actual intensity of communication between the project partners

Communication intensity measures	Io-Digital-Pen	ORA	Mistral
I- Frequency of verbal communication:			
- Face-to-face meeting	Once/two months	Two to three times/year	Quarterly
- Video conference	Weekly	Once/three months	Monthly or quarterly
- Phone calls (frequency & by whom)	High, directly by the team members and partners	When needed, by predefined channel	Medium frequent,
- Email exchange (frequency & by whom)	Frequently, team members	When needed, by predefined channel	Frequently, by the supervisory committee
Average of frequency of verbal communication	High	Low	Medium
II- Frequency of nonverbal communication (flow of information and knowledge sharing: reports, data, studies, plans, etc)	High	Medium	Medium
Overall intensity of communication level (I+II):	High	Low	Medium

6.3.2 Actual coordination with the NPD project partners

To gauge the actual intensity of coordination activities, I use the measures developed in chapter 4. The measures were two-fold: the rate of tangible and intangible resources sharing between the NPD team of the network lead company and the project partners (monthly basis), and the extent of effort and time spent managing the dependencies of activities with the partners.

According to the Company-A *io-Digital-Pen* project team, working and integrating the development process with the project strategic partners was mandatory, and the team communicated and coordinated with the project partners (A4Vision, Design Partners, and Anoto) without being told to do so. The project team perceived coordination of development activities with partners to be highly important and acted accordingly.

During the R&D phase of the *io-Digital-Pen* project, some suppliers, such as Design-Partner and Anoto, suggested making some changes in the design and function in order to reduce the cost, improve some aspects of the product, and to reduce the complexity of manufacturing. The project manager and his team were convinced that the earlier they coordinated with project partners, the better the project performance would be. Otherwise, the project would have faced problems later on, wasting time, money, and effort. Consulting with the project partners from the beginning of the project avoided re-work and introduced overlap of activities during the execution of the project.

The project team could not establish a project schedule before establishing the deliverables and the responsibility matrix for those deliverables. For instance, there was a project time line, showing clearly what Company-A had to do, what the project partners had to do, and the interdependency between them. In this way, if a partner had a delay executing one activity, it would be clear which other activities were going to be affected by that delay.

During the development of *io-Digital-Pen* project, the team shared tangible and intangible resources whenever needed. First of all, the database and project management system were shared with A4Vision, Design Partners, and Anoto. This way, all participating entities were informed daily about the project's progress. All project partners were able to prepare their part of the work on time. In case there was a delay or any sudden change in the project plan, the project partners were informed in a timely manner so that they could immediately adapt to the new plan. In some cases, individuals from the partners worked on-site with the *io-Digital-Pen* project team for a couple of days, thereby permitting the *io-Digital-Pen* team to benefit from the knowledge and experience of their partners. This approach to the work enabled the *io-Digital-Pen* project team and their partners to work smoothly and cohesively to develop the digital pen project. This meant that a smooth transition of output from one partner become seamlessly the input for Company-A and vice-versa, minimising the amount of re-work. Due to high number of activities to be executed, on weekly basis, the *io-Digital-pen* project manager and team dedicated a significant amount of their time and efforts on coordinating the development activities and resources with the project partners. For more information about the coordination activities between io-Digital-Pen project team of Company-A and their strategic partners, please see section 5.2.7.2.

During the execution of the *ORA project*, the team members had to follow standard operating procedures established by Company-B to coordinate activities with the project partners (Evotec, Amard, or Alkermes). However, it was often mentioned that the coordination of activities was not as easy as the ORA team had anticipated at the beginning of the project. There were several reasons for this: i) The NPD project included three different sub-projects, which were conducted successively and involved different partners. Moreover, the long development cycle time made it difficult for the up stream and down stream partners along the development process to know about each other's capabilities; ii) The high complexity of activities to be executed by different partners. It was difficult for the ORA development team to follow and understand the development process of these activities. Instead of overlapping their activities, the ORA team waited for the partner to get the final output before starting the next activity; and iii) The high uncertainty in the output of each single activity. This uncertainty made the development team unwilling to know about others' activities until their work had been done.

The above factors were the main reasons for not overlapping the development activities with three project partners; Evotec, Amard, or Alkermes. However, there was very limited repetitive or rework of activities. As a result, there were no waste of time and resources due to the rework. In addition, the transition of output from one partner to another was generally smooth and well prepared. To a large extent, this limited rework was due to the control over the project that was imposed by the top management. The top management spent, on monthly basis, a moderate amount of their time and efforts in monitoring and controlling the development activities of ORA project. This is because the number of activities had to be executed, monthly, was very low. In addition, the unit-time to execute the activities was long.

The ORA project team shared the development project plans with the strategic partners, so that every one involved in the project knew what were the milestones, what would be the consequence of any possible delays, and who was responsible. The partners also shared some IT tools, such as the Microsoft (MS) project management software and database. For more information about the coordination activities with the project strategic partners, please see section 5.3.7.2.

Because *Company-C* has invested in its partners – by buying shares of the partners' companies – the Mistral project team and their partners were able to share knowledge and important and sensitive data, such as market studies, databases, and the project plan. The Company-C NPD project team and HBS and Asitrade teams created mutual product goals for this project. They jointly developed a Project Management Information System (PMIS) that provided the means for monitoring the network of tasks. The monitoring function ensured that both management teams involved with the Mistral project received reports in sufficient detail and frequency to enable them to identify and correct problems early. This helped in managing the interdependency between activities executed across the project partners. This interdependency was a conventional producer/consumer dependency between the work processes of Company-C and the partners' teams. However, due to the complexity of the development processes and the involvement of the project partners' team in other development projects, the project management faced some problems in managing effectively the interdependency. A moderate percentage of the project management time and effort had been spent on managing tasks interdependency with the both HBS and Asitrade.

The project plan also served as a principal coordination mechanism at the Mistral project level. Both Company-C team and their partners shared production planning and operations, procurement, order processing, engineering changes and design. The Company-C project management's culture of sharing resulted in improving customer service as well as speedy response to environmental changes.

Occasionally, experts from the HBS and Asitrade came to work at the Company-C site for a week or so. This occurred for the most part when the Company-C team needed to insert a part in their machine that had to be manufactured at the partner facility. For more information about the coordination activities between Mistral project team of Company-C and project partners' teams, please see section 5.4.7.2.

Table 6-3 shows the actual intensity of coordination activities that the network lead companies (Company-A, Company-B, and Company-C) have spent in coordinating the NPD process with the project strategic partners.

Table 6-3: The actual intensity of coordination activities

Coordination intensity measures	Io-Digital-Pen	ORA	Mistral
I- Rate of resource sharing (monthly basis):			
- Tangible resources	Medium	Low	Medium
- Intangible resources	High	Medium	Medium
II- The amount of time and effort in managing the activities interdependency	High	Medium	Medium
Overall coordination intensity level (I+II):	High	Medium	Medium

6.4 The organisational attributes

After analysing the contents of the interview, I identify the most important organisational attributes that have greatest impact, either positive or negative, on actual communication and coordination activities with the NPD project strategic partners. Five organisational attributes were mentioned or implied frequently, explicitly or implicitly by the interviewees (see Appendix E). The first three attributes are related to the company level: centralisation, formalisation, and number of hierarchical levels. The other two attributes are related to the NPD project: empowerment of the NPD project team and the power of the leadership. These five attributes are shown in Figure 6-1. The relationship between these attributes and the communication and coordination will be analysed and disused in the next chapter.

In the following paragraphs I present some examples of the organisational attributes. The examples are extracted from the case studies reports (Chapter 5). Based on previous researchers (Moenaert et al., 1994; Malhotra, et al., 2001; Kirkman & Rosen, 1999; Thomas

& Tymon, 1993; Pugh, et al, 1969; Marsden et al., 1994), some measures have been developed to assess the state of these organisational attributes in the three case studies.

Figure 6-1: Five organisational attributes impacting the integration process elements

6.4.1 Centralisation

Centralisation is defined as the extent to which decision making and power are concentrated in the hands of relatively few individuals belonging to the top management of the organisation (Moenaert et al., 1994). On the other side, decentralisation is defined as the degree to which decision making authority is pushed down to lower levels of the firm (Schilling, 2005). Figure 6-2 shows the interaction of the top management and the operational management in decision making within a firm. Table 6-4 presents a summary of the measures used to assess the decentralisation in the three cases. I consider the organisation as decentralised if most of these measures are met.

In *Company-A*, the decentralisation style of management is reflected in all the NPD project's phases. For instance, any one in the company can present his ideas for new products to the others regardless of position. As a matter of fact, most of the new product ideas came from the lower levels in the organisation. One of the business units directors said, "*We hire the best* *engineers and marketing people and give them all the freedom to do their job; they know better than us*" (for more information, please see section 5.2.5.1).

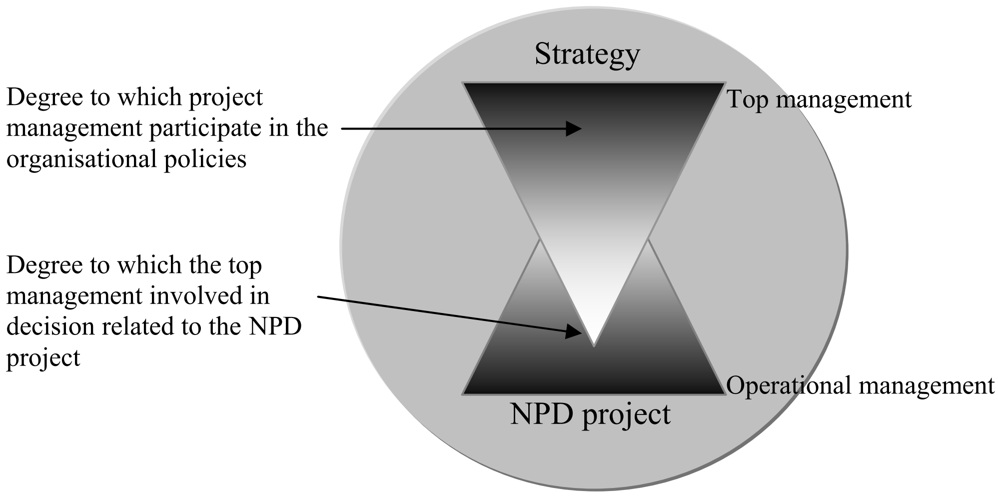

Figure 6-2: Interaction of the top and operational managements in a firm

Table 6-4: Measures of the decentralisation of the organisations
(Adapted from: Malhotra, et al., 2001)

Measures of decentralisation
The involvement of the NPD project members in decisions related to the investment of new equipment and technology.
NPD project members work autonomously with little or no management guidance.
The degree of participation of the NPD project members in the change in the organisational policies affecting their area.
The degree of participation of the NPD project members in hiring and staffing decisions.
NPD project members determine their own workflow, scheduling or order of tasks.
The involvement of the NPD project members in day-to-day decisions on product development issues.

The *io-Digital-Pen* project team was able to take the necessary actions to correct, adjust, or make changes to their product as long as these changes would not affect the project plan. Top management's roles were to control the overall project performance and coordinate this project with the other NPD projects (e.g., make sure the resources required for each NPD project was available, the NPD project fit Company-A strategy, etc.), and they became involved only when the project over-reached the plan in terms of cost or time. This is to say that the amount of freedom the *io-Digital-Pen* project team has in dealing with their job, and the authority to make decisions regarding repairs, programming, maintenance were quite high. For more information, please see section 5.2.5.1.

The project manager and his development team participated actively in selecting the project partners. In this project, 60% of the project partners were well known to Company-A (having worked with Company-A on previous NPD projects), while 40% were new to the company (partnering with Company-A only for the *io-Digital-Pen* project, as was the case with Anoto). These partners were selected solely by the project manager and his development team. Top management was involved only in making sure that the new partner would not impact the business and/or the long term strategy of Company-A. For more information, please see section 5.2.6.

The centralisation issue in *Company-B* is different from that of Company-A. Top management was involved in most of the decisions that related to the ORA project. As was the case with most biotech projects, the development processes and activities of the ORA project were very expensive, required a lot of resources, and lasted 12 years. The project was broken down into three totally different sub-projects, which were conducted successively and involved different functions and partners. To be able to coordinate and control these interrelated sub-projects, in addition to the other projects the company had in its pipeline, Company-B had adopted a centralised management system. Two examples reflecting this system can be taken from different R&D phases of the ORA project; the target molecule selection phase and the project partner's selection phase.

In the target molecule selection phase, which was in the beginning of the ORA project, the discovery group, as a result of their intensive research, came up with a lot of ideas, data, and information about possible molecules. The group tried to focus its research on certain molecules, since the available resources did not afford working on all of them. The product marketing people advised the discovery group about the market needs (e.g., what type of product was needed the most, what disease had to be attacked, etc.). Both groups came to the Executive Management Board (EMB), which included the CEO, with possible molecules. The EMB selected the strategic molecules to be developed into a new product that might contribute to Company-B's growth. See section 5.3.4.3 for more information.

The second evidence of the centralisation system at Company-B can be seen in the partner selection process. As mentioned above, the basic molecule for ORA project was discovered and patented by Company-B discovery research. This molecule was considered a breakthrough for Company-B, potentially opening a new market. The company has neither the expertise nor the resources to develop this molecule. Although Company-B prefers to develop its products in-house, due to the lack of relevant expertise and resources, it decided to outsource a considerable part of the ORA project to external partners. Company-B's goal was to develop this product and, at the same time, build expertise in this domain by learning from the project partners. The decision of partner selection had been taken up jointly by top management and the functional department, in which the candidate partner was to participate. The functional department screened worldwide companies who were experts in this domain, and selected the best possible partners, based on their functional expertise. Then, top management selected one based upon respective strategic aspects (partner vision and strategy, current and future business, short-term returns, long-term potential, etc.). See section 5.3.6.1 for more information.

Company-C's top management and the project management team have succeeded in striking a balance between centralisation and decentralisation of its structure. The company is very much project-oriented. Its structure is based on business units and product lines, where the engineers have more knowledge and know-how than top management about product development. This structure enables the product development project members to be involved in decisions related to investments to be made in the development projects, and to determine their own workflow and order of tasks. See section 5.4.3 for more information.

However, the final decision rest with the top management. For instance, in the Mistral project, Gate 3 was the most important gate, where the choice of the most efficient proposal and solution had been made. In that gate, the decision to accept proposals had to be made by the GEC (General Executive Committee). When the GEC was convinced that the project had potential, a green light was given to the product line to go ahead and develop the new concept. When the NPD project passed gate 3, it meant that the real development work had been started. See section 5.4.4.2 and 5.4.5.3 for more information.

The extent to which decision making and power are concentrated in the hands of top management of the organisations in the three case studies is presented in Table 6-5.

Table 6-5: the level of decentralisation in the three case studies

Company name	Level of decentralisation
Company-A	High
Company-B	Low
Company-C	Medium

6.4.2 Formalisation

Formalisation has been defined in many different ways by different researchers. Nohria and Ghoshal (1997) define formalisation as the use of systematic rules and procedures in decision making. Gupta et al. (1986) refer to formalisation as the emphasis within the organisation placed on following rules and procedures in performing one's job. Fry and Slocum (1984) define formalisation as the degree of job codification and rule observation. It is an organisational device for prescribing what, when, and by whom tasks are to be performed. For them, there are two elements of formalisation: the existence of rules and procedures, and the organisation's exercise of control to enforce these rules and procedures. Malhotra et al. (2001) define formalisation as the level of detail in the specification of jobs and the explicitness of the rules for compliance. It provides a structured context for the exchange of resources and systems. However, in this research, formalisation of an organisation is defined as the degree to which the organisation utilise rules, procedures, and written documentation to structure the behaviour of individuals or groups within the organisation (Schilling, 2005). Table 6-6 lists the measures used in the case studies to assess the formalisation of the organisations.

Table 6-6: The measures of formalisation
(Adapted from: Malhotra et al, 2001; Marsden et al, 1994)

Measures of formalisation
The existence of comprehensive rules for all routine procedures and operations with regard to NPD process (operation).
The existence of the procedures to follow in dealing with arising conflict
The existence of written rules and procedures for the NPD process (NPD process model)
The job description for the NPD project members' job contains all of the duties performed by individual members.

The management of Company-A has adopted a light formalisation system that is reflected in most of the company's functions and activities. The system focuses on the outlines and formalises only the main activities. A lot of freedom is given to engineers to conduct their tasks in the manner they think best. For instance, the idea generation phase at Company-A is not formalised. Ideas can come from any one within or outside of the company (e.g., partners). However, the development of the idea has to pass through a semi-formalised process model. Company-A has implemented a simple but rigorous process to steer its product creation projects. This process gives a lot of day-to-day freedom to the project teams, but it requires them to prepare for, and pass, three tough management reviews, or "toll gates," before commercial launch. These gates are passed in the course of lively meetings attended by the business and product unit heads, R&D director, as well as senior engineering and marketing mangers. Company-A management follows this model to achieve a certain output, in a certain time, within certain conditions. For more information, please see section 5.2.4.

Because there were many partners participating heavily in the development activities in the execution phase of the *io-Digital-Pen* project, Company-A developed clear specifications, definition of the deliverables, roles and responsibilities, who does what in the project, and work break down structure, all aimed at coordinating the activities execution between partners. Some of those arrangements were already mentioned in the contract between Company-A and its partners; others were developed by the project leader, and reflected the project management culture at Company-A. For more information, please see section 5.2.7.2.

The formalisation of the management system at *Company-B* is reflected in most of its activities, such as the target molecule selection, drug development process management, partner selection, conflict resolution, and communication process with the external partners. There is a formal mechanism for selecting target molecules that the discovery group has to work on, and that will proceed in the development pipeline. There are three main entities interacting with each other to select the right molecules: the product marketing group, the executive management board (EMB), including the CEO, and the discovery group. See section 5.3.4.3 for more information.

The process for drug development is also highly formalised and standardized in the sense that it is composed of several discrete stages. The main activities in each phase are to some extent known (e.g., the number of human and chemical studies and tests in each phase, how many patients, and where to take them - the studies in USA cost as much as the double of those in Europe--and possible output of each phase). There is also a standard process for managing the development projects. This management process is well documented, and shows what input is required from the team, what resources are needed, how much time and cost are required for development, and what documents and information the team has to present to gain top management's approval. See sections 5.3.4.3 for more information.

At Company-B, partner selection is a formalised process and based on a hierarchy of criteria that are reviewed by top management. The company is interested in partnering with others if there is a potential in the alliance for either direct output or output occurring in a short period of time. In either case, there must be first, enhancement of one of Company-B' therapeutic areas, or second, creation of a new therapeutic area for Company-B. In the latter instance, the product should be extremely strong and revolutionary. Company-B is only interested in niche areas, very narrow areas of research where there are few competitors. For more information, please see section 5.3.6.1.

Company-B knows that a moderate degree of conflict in an alliance can be quite healthy and a stimulus to creativity and improved performance. The key is to have a process in place that will keep conflict from getting out of hand and causing serious disruption. Hence, Company-B has strived to reach agreement as to how conflict among the parties should be handled. Jointly with the partners, Company-B has created three counsels charged with monitoring the partners' relationships and solving problems while they were small. These three were a joint research counsel, a joint collaboration counsel, and a joint decision making counsel. Each is working in a different domain to solve different kinds of conflict. The counsels are made up of an equal number of people from Company-B and the partner. However, because Company-B was responsible for the entire process of the project, it was agreed that in cases where a joint decision could not be reached, Company-B would have the deciding vote. If the partners could not agree, they would defer to judgment of the two CEOs of the respective companies. See section 5.3.6.4 for more information.

Even the communication processes were formalised. Since the very beginning of the project, the ORA project development team were in agreement concerning the means of communication with their project partners. A formal communication plan was created, with certain rules on how to communicate. These included: who should be involved; who should communicate with whom; who should be informed; if an individual was unavailable, who should be the replacement; when information has been requested, how long should it take to get a response. The idea behind this was to streamline the process of communication and to facilitate the flow of information between partners. See section 5.3.7.1.

Over the years, *Company-C* evolved from being a very rigid and formalised company into one that is flexible and informalised. It is a very open environment with few formalised processes. Top management encourages people to talk to each other. Managers meet and speak informally with the technicians. Though this sometimes leads to conflicts, such as technicians' managers may not feel comfortable with direct contact between their employees and top management, there was no formal process to handle such conflicts. See section 5.4.3 for more information.

The NPD process at Company-C was the only activity that was formalised. There were seven gates and eight phases that any NPD project had to go through. Phase 0, gate 1, phase 1, and gate 2 are related to idea generation and marketing studies and are not as structured as the other phases (with less specificity on how the front end should be conducted). These two phases are more internal processes and had been called at Company-C the "internal kitchen" of the product line (PL). Please see section 5.4.4.

There did not exist any comprehensive rules for all routine procedures and operations with regard to the development processes. Rather, the actual job duties were shaped more by the development project team members than by a specific job description. See section 5.4.3.

The level of formalisation of the three case studies is shown in Table 6-7.

Table 6-7: the level of formalisation in the three case studies

Company name	Level of formalisation
Company-A	Medium
Company-B	High
Company-C	Low

6.4.3 Number of hierarchical levels

The number of hierarchical levels refers to the number of layers between the NPD project team members and the head of the R&D organisation (Hall et al., 1967). The hierarchy of authority is impersonal and the superior position is held by one having greater expertise. To identify the number of layers in the three case studies, first I trace the reporting system in these companies (e.g. through how many layers the head of the R&D gets information about the NPD project). Secondly, through how many layers the head of the R&D decisions are communicated to the project team. Figure 6-3 shows the reporting and decision flow through the management layers.

As a project-oriented company, *Company-A* is organised around four business units: Control Devices, Video, Interactive Entertainment, and Audio. These business units' senior vice presidents, who also act as marketing directors for their respective businesses, report directly to the CEO. In some business units, such as Control Device, the largest business unit at Company-A, there is also a vice president of engineering. The business units are comprised of a number of product units. Company-A's management assigned the development of *io-Digital-Pen* project and related software to the Retail Pointing Devices product unit, which was one of four product lines within the Control Devices business unit. This product unit is responsible for designing and developing a broad range of mice and trackballs. The R&D director was also involved in the development process of the *io-Digital-Pen* project and is also the individual to whom the project manager reported. In this reporting system, there were four management layers separated between the *io-Digital-Pen* project leader and the R&D director.

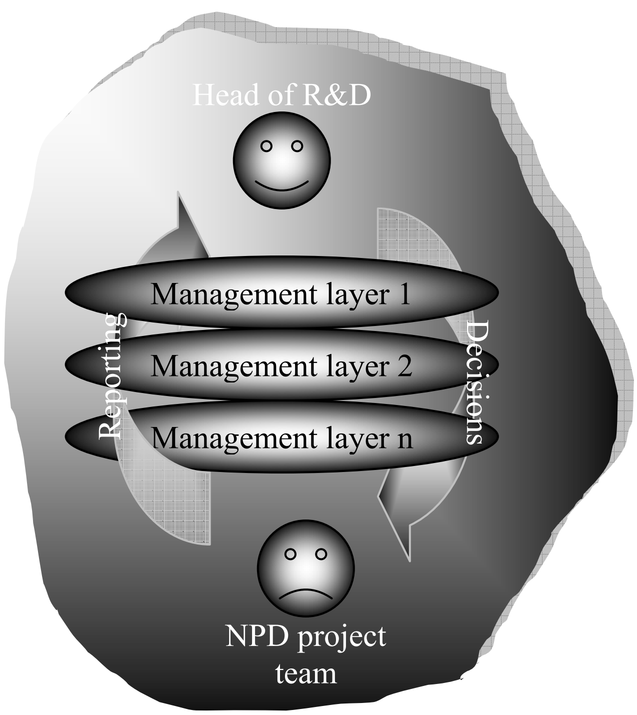

Figure 6-3: the reporting and decision flow through the management layers

Unlike with Company-A, tracing the reporting and decision system at *Company-B* was uneasy task. Company-B is organised around four main functions (known at Company-B as "corporate"): R&D, production, sales, and administration. Corporate Research and Development is the heart of Company-B, and is seen by top management as the main engine for growth. The R&D facilities are located worldwide, with more than 1000 researchers. Although there are four main business units (BUs) at Company-B, unlike what one tends to find at most pharmaceuticals, the Research Division, is not organised around these BUs. The research division serves all the BUs, and does research for all of them. Company-B is a vertical company, with many layers between the R&D director and operational management. The control and reporting systems are quite sophisticated and involve many actors. See section 5.3.3.1 for more information.

Company-C is very similar to Company-A in terms of hierarchal levels. In the beginning of 2002, the company introduced a new organizational structure organises around three Business Units (BU): folding carton, corrugated board, and flexible materials. The new structure was created to support the company philosophy that encourages people at all levels to speak with each other and to share knowledge and experience directly and informally. To achieve this culture, the company tried to remove any possible barriers to this kind of contact. Currently, Company-C has a light organisation structure, almost flat. There are few management layers between the employees and the mangers, or between the project manager and the R&D director. Only four management layers separate the project manager of the Mistral project and the R&D director. Please see section 5.4.3 for more information. The hierarchical levels in the organisation of the three case studies are shown in Table 6-8.

Table 6-8: The number of hierarchical levels in the three case studies

Company name	hierarchical levels
Company-A	Few (four levels)
Company-B	Many (more than ten)
Company-C	Few (four levels)

6.4.4 Team empowerment

Although definitions of empowerment vary, in the case of NPD I adopt Forrester's (2000) definition of empowerment as the freedom and ability of the core team to make and execute the decisions that are critical to the operation or direction of their project. Table 6-9 presents the measures I used to assess the extent to which the NPD team is empowered.

Table 6-9: the measures of the team empowerment
(Adapted from: Thomas and Tymon, 1993)

Measurement of team empowerment
The extent to which team members could select different ways to do their work.
The extent to which team members determine what and how things were done.
The extent to which team members felt a sense of freedom in what they did.
The extent to which team members made their own choice without being told by management.
The extent to which team members had a lot of choice in what they did.

Company-A's culture gave the *io-Digital-Pen* project team members the freedom and ability to make and execute the decisions that were critical to the operation and direction of their project. This enabled them to select different ways to do their jobs and to make choices independent of management input, (See section 5.2.4 and 5.2.4.6). Moreover, the NPD of *io-Digital-Pen* participated actively in selecting the project partners (see section 5.2.6), and the machines and tools to be used in the project.

Unlike development projects in other industries, at Company-B it is almost impossible to assign one project manager and one team to conduct an entire biotech project, from idea to market. This is due to the long development cycle time of biotech projects (10 to 12 years). The ORA project was divided into three main sub-projects. Due to the different teams and the relatively large number of people involved in the development activities, the top management found it necessary to be heavily involved in all decisions related to the sub-projects, particularly in that these sub-projects were connected, with the output of one leading directly to the next. Any change or modification in one sub-project potentially could impact the entire project.

At Company-C, there were from 65 to 130 people contributing to the Mistral project, representing various functions, such as electrical, mechanical, software, hardware, and electronics engineers. There was a permanent project manager and project committee, which consisted of the cross functional development team leaders. Each of these leaders was responsible for his function's team members. During the execution phases of the Mistral project, the project manager and his project committee discussed all the problems and challenges they were facing, and took appropriate actions. Please see section 5.4.5.3 for more information.

However, the project team members were changing; due in part to the differing needs of each phase. In some phases, the number of workers was much higher than in others, depending upon the activities to be executed in a given phase. Experts from other functions participated in solving very precise technical problems. Once those problems were solved, they exited the project. This was also the case with the sales and marketing people. Once their particular functional goals had been reached, they would return to their own worlds. It was obvious that the team members who only participated in specific functions were unable to take decisions related to the functionality of the product without permission from the project manager and his committee. On the other hand, the permanent project team members who had been with the project in the early phases, had more freedom in doing their job. In addition, some of the technical choices and methods of execution had been made by the team. In some development activities that were considered critical in the development process of Mistral project, the project committee and project manager had to be informed before the permanent team members could take any action. Please see section 5.4.5.3 for more information.

The extent to which the development teams in the three case studies were empowered is shown in Table 6-10.

Table 6-10: The empowerment of the NPD project team

Company name	Development team empowerment
Company-A	High
Company-B	Low
Company-C	Medium

6.4.5 Power of the project leadership

Marsden et al., (1994), and Pugh, et al., (1969) defined the power of the project leader as the extent that the leader is able to make decisions related to the NPD project. The power is the ability to change another's attitudes, beliefs, or behaviour in an intended direction (Corfman & Lehman, 1987). Table 6-11 shows the measures used in this section to assess the power of the project leader in the three case studies.

The project manager of the *io-Digital-Pen* project was an electrical engineer with more than ten years of experience working with Company-A. He had full responsibility for the project development. The top management became involved only in the two gates, go and investigate and go and develop, or when the project was out of plan (cost, schedule and performance, CSP). Most of the important decisions in the *io-Digital-Pen* project were made by the project leader, sometimes jointly with his team: type of new equipment to be bought; the cost of the *io-Digital-Pen* project; workflow priorities; and the price of the final product. All of this reflected the extent to which the project manager was empowered to manage the project, (see section 5.2.4.6). Moreover, most of the new partners (40% of the project partners were new to the company, partnering with Company-A only for *io-Digital-Pen* project) were completely selected by the project manager and his development team, with keeping the top management informed, (see section 5.2.6).

Table 6-11: the measures of the power of the project leader
(Adapted from: Pugh, et al., 1969)

Power of the project leader
During the NPD project execution, the project leader is considered powerful if he made, or participated in making the following decisions:
Appointment (some) of NPD project team members
Type or brand of new equipment to be bought
Cost of the NPD project
Operations priorities
Suppliers of materials to be used
The number of people to be employed for the project?
Evaluating worker performance

With Company-B's ORA project, the project manager was mainly coordinating the development activities, with limited decisions to make (see section 5.3.5.4). There were two committees for monitoring and controlling the project: the research supervising committee, and the product development supervising committee. These two committees were chaired by the head of the research group and the head of the development group. Both heads were represented in the Executive Management Board (EMB) and delegated by it to follow the NPD projects. Most of the decisions related to the ORA project development activities were made by these two committees, each operating from its respective area of expertise. For more information, please see section 5.3.4.3.

Because the project team consisted of representatives of different functions, each contributed from its particular functional area. For example, the formulation people were instrumental in deciding the following: how to obtain full information about the target, how to test it, when to use the materials for clinical study, etc. The project manager's task was mainly to bring together all contributions and to coordinate inputs of different functions within his sub-project (see section 5.3.5.4).

The project manager did not control the project budget. In stead, finances were controlled by a separate central function at Company-B called the finance department. This function managed the budget of the on-going development projects, so that the resources for the ORA project were allocated relative to other projects. Additionally, the ORA project manager was not responsible for selecting the project partners and suppliers, or even the appointment of NPD project team members. See section 5.3.5.4.

The power that the project managers held in Company-C was similar to what was occurring at Company-A. Once the Company-C Company approved the Mistral project concept at gate 3, a project manager was assigned to lead the project. From time, the rest of the development process was his responsibility.

The power of the project manager was evident in the decisions he was able to make. The project manager decided what type and brand of new equipment would be purchased, and which training method would be used for the project team. In addition, he made all decisions related to the appointment of the project team members, and created what was known at Company-C as the project committee, made up of cross-functional development team leaders. This committee consisted of electrical, mechanical, software, and electronic functional leaders - leaders of the functions for this particular project, but not permanent heads of the functions. Each functional leader was responsible for specific project phases, depending upon his function. Unlike the project development team, which was subject to change over the course of the project, the project manager and the project committee were permanent and responsible for the entire project, from concept development and feasibility study to bringing the new product to the market and launching the first machine. See section 5.4.5.3 for more information.

Table 6-12 shows the extent to which the project managers were empowered in the three case studies.

Table 6-12: the power of the NPD project managers

Company name	NPD project managers power
Company-A	High
Company-B	Low
Company-C	High

6.5 Conclusion

This chapter presented the findings from the case studies, grouped under three main categories: (1) the NPD project performance, in which the performance of the three projects was gauged according to the development cost, time, and the quality of the product; (2) the integration process elements, wherein the intensity of communication and coordination activities between the NPD team of the network lead company and project strategic partners were measured; (3) identification and assessment of the most important R&D organisational attributes having the greatest impact on the integration process elements.

The next chapter will analyse and discuss the results obtained from the findings from the three case studies.

7 Analysis and Discussion

7.1 Introduction

In this chapter I discuss the results obtained from the three case studies. As mentioned previously, this research investigates the impact of the R&D organisation design in the "network lead company" on the integration process elements (communication and coordination) with its NPD project strategic partners, and the subsequent effects on project performance. The output of the analysis should enable us to answer the research question: how can the network lead company design its R&D organisation to support and facilitate communication and coordination with the NPD project strategic partners, and thereby improve the project performance. Based on the discussion and analysis, several propositions are developed, then, to enrich the discussion, are confronted with the literature.

As was the case in Chapter 6, the structure of the current chapter will nonetheless be based on the preliminary model developed in chapter three. However, I added the five organisational attributes identified in the previous chapter to the preliminary model (See Figure 7-1). Chapter 7 consists of four main sections. The first, investigates the impact of NPD project characteristics on the required intensity of communication and coordination. The second section analyses the relationship between the actual and required intensities of communication and coordination and the NPD project performance. The third, investigates the relationship between five R&D organisational attributes and the actual intensity of communication and coordination. Finally, the fourth section presents the emergent model.

7.2 NPD project characteristics impact on the required intensity of integration process elements

In this section, I argue that the required intensity of communication and coordination between the network lead company's project team and the project strategic partners emerged essentially from the NPD project itself. I investigate project characteristics and their impact on the required level of intensity.

In the three NPD projects, *io-Digital-Pen*, *ORA*, and *Mistral*, the high complexity and uncertainty in converting the abstract ideas into tangible products, and delivering them to potential customers, required the application of many different skills and solutions to a variety of functional problems. Thus, the projects required the participation of many functional specialists from different partners. Such specialisation of labour created interdependencies among them. Each specialist relied on members of other functional department of other partners to do their jobs effectively so the group could achieve its collective purpose. This interdependency called for more communication and coordination. However, the difference in the Development Cycle Time "DCT" (short, medium, and long) across the projects impacts the communication and coordination differently.

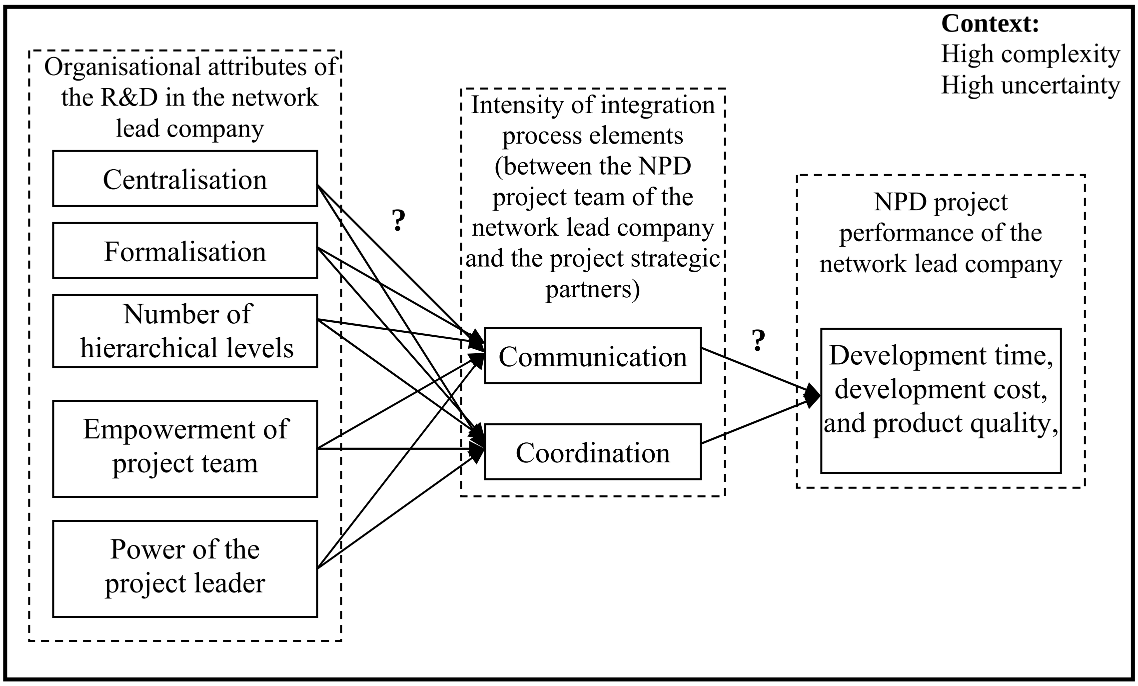

Figure 7-1: A model of R&D organisation in the network lead company

The analysis of the findings revealed that the required intensity of communication and coordination was dominated by the DCT of the NPD projects, commonly known as typical or normal development time of the NPD projects in an industry (Galbraith, 2000). Based on the case studies selection criteria, the three companies differed along one main dimension, the DCT, due to type of products that were developed. As shown in Figure 7-2, the three NPD projects in this research are positioned on a DCT continuum, from short to long, and categorised (C1&C2) accordingly. I argue that the required intensity of integration process elements between the project team of the network lead company and the strategic partners' teams is based on where the project is positioned on this continuum.

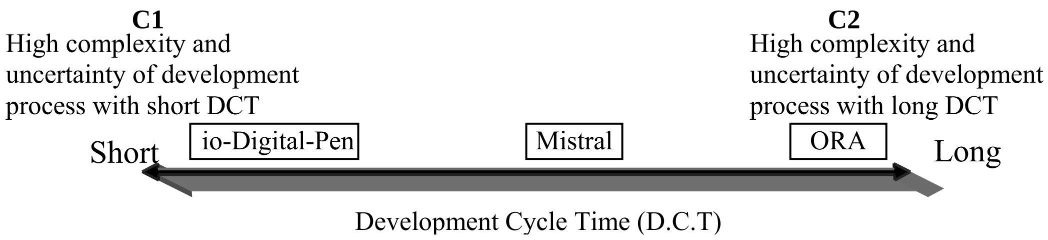

Figure 7-2: Categories of NPD projects

As shown in Table 7-1, the development cycle time (DCT) of the io-Digital-Pen project was approximately 14 months. The average number of activities that executed weekly in this project was relatively high (two to three tasks per week). Moreover, almost half of development tasks were carried out in parallel. The average 'unit-time' to execute a task in the io-Digital-Pen project ranged from just a few days to weeks. These characteristics demonstrate why measuring the project development progress on a monthly basis would have been risky, considering, for instance, that it would have been difficult to fix a problem occurring at the beginning of the month. The project required speedy, flexible and responsive organisation to handle the highly frequent and timely flows of information and resource sharing between Company-A any and its project strategic partners. Table 7-1 shows the characteristics of the three NPD projects.

Table 7-1: Characteristics of the NPD projects

NPD project name	Complexity & uncertainty	DCT	No. of task executed monthly	Unit-time to execute tasks	Nature of tasks execution
Io Digital (Company-A)	High	Short 14 months	High (Two to three/week)	Short (from few days to weeks)	In parallel and sequentially
ORA (Company-B)	High	Long 6 years	Low	Long	Sequentially
Mistral (Company-C)	High	Medium	Medium (Two to three/month)	Medium (from two weeks to a month)	Mainly sequentially and occasionally in parallel

Company-B was on the other extreme: the *ORA* project was characterised by very long DCT, about 6 years (twelve years until the end of the whole project). In the course of the project, the required intensity levels of communication and coordination were low and medium respectively. This is because the average number of tasks to be executed on monthly basis was not extensive. In addition, the nature of this industry does not permit parallel task execution. Instead, tasks were carried out consecutively, with the output of one task constituting the input of the next. The average 'unit-time' to execute a task in the ORA project was two to three months. These characteristics explain why the development progress was measured quarterly.

Comparing the *io-Digital-Pen* project to the *ORA* project, the required intensities of both communication and coordination at *io-Digital-Pen* project were as follows:
i) *Higher intensity of communication*: higher frequency of verbal communication (including face-to-face meeting, video conferences, phone calls, and email exchange), and higher rate of information flow and knowledge sharing (including technical and market reports and data);
ii) *Higher intensity of coordination*: higher rate of resource sharing (tangible and intangible resources) and more efforts in managing the interdependency as measured in the percentage of time spent on it.

Mistral project differed also from the other two projects. There was a need for medium intensity of communication and coordination with the project strategic partners. Table 7-1 shows also that the case of the development time of the project was three and a half years. The average number of activities was approximately two to three per month. The majority of tasks were carried out sequentially. However, some were carried out in parallel. The average 'unit time' to execute a task in the Mistral project ranged from two weeks to a month.

Thus, the following proposition is postulated.

Proposition 1:
In the context of highly uncertain and complex projects, the shorter DCT, the higher is the required intensity of communication and coordination with the NPD project strategic partners.

The proposition which grew out of the data is summarised in Figure 7-3.

Some researchers have already put forth factors that influence the communication and coordination required between functions (within a firm), or between partners (interfirm relationships). However, none of these researches discussed the impact of the DCT factor on communication and coordination with the NPD project strategic partners. Studies by Tushman (1979), Van de Ven and Ferry (1980), and Daft and Macintosh (1981) showed that information processing increases or decreases, depending on the complexity or variety of organisations' tasks. Bensaou and Venkatraman (1995) studied partners' relationships and found that the information-processing needs are linked to three types of uncertainty: environmental, partnership, and task. Gupta et al (1986) investigated the R&D-marketing interfaces and concluded that the integration needs (coordination and control) required to improve the innovation success depended on organisational strategy and environmental uncertainty (competition, consumer requirements, technological changes and regulatory constraints

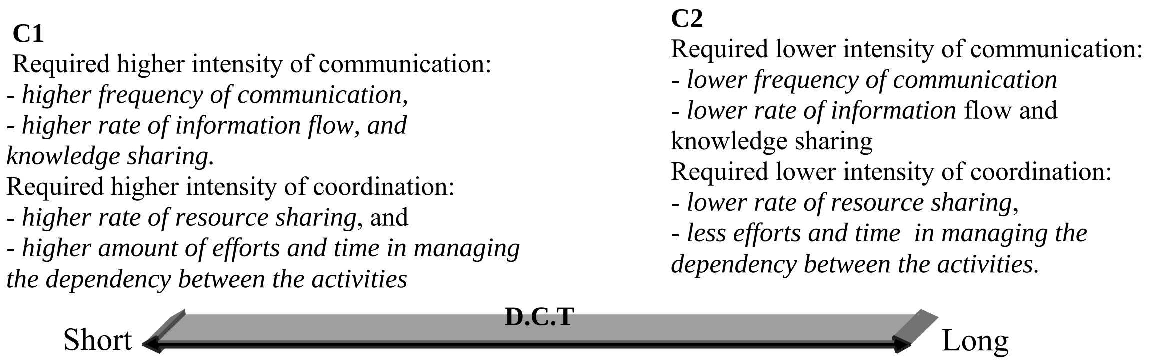

Figure 7-3: Required intensity of integration process elements with project partners

However, a number of academics conducted research on DCT, trying to understand the impact on the success of innovative projects. These studies reveal the importance of DCT as one of the main factors that should be taken into consideration in managing innovation. Lakemond and Berggren (2006) suggested taking into account the project DCT in co-location decisions. Griffin (1997 and 2002) linked the DCT with project strategy (strategic intent, level of innovativeness and technical difficulty and complexity).

7.3 Relationship between the actual and required integration process elements and the NPD project performance

The analyses and discussion in this section focus on the relationship between the intensity of the integration process elements and the NPD project performance (see Figure 7-4). The analysis of the three NPD projects revealed that the actual intensity level of integration process elements (Tables 6-2 and 6-3) that led to efficient performance of the NPD projects (Table 6-1) was different in the three projects. Each NPD project team had certain intensity levels of communication and coordination with the project strategic partners to efficiently develop the new product. The question that arises here is: *what intensity level of integration* *process elements does the NPD project team require with the project strategic partner to efficiently develop the product?*

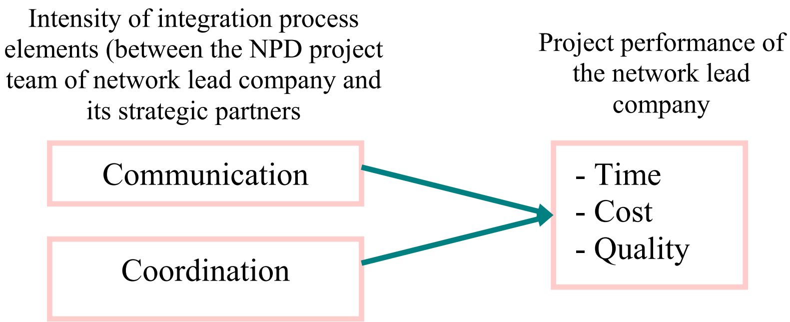

Figure 7-4: relationship between intensity of the integration process elements and NPD performance

The actual intensity levels of the communication and coordination and the correspondent performance in the three cases are shown in Table 7-2 and Table 7-3. As shown, on the one hand the overall performances of the three NPD projects (*io-Digital-Pen* of Company-A, *ORA* of Company-B, and *Mistral* of Company-C) were rated within the limits of successful projects for this type of project "new to the firm." On the other hand, the actual intensity of communication and coordination along the *io-Digital-Pen* project, for instance, was higher than that in *ORA* project. The case of the *Mistral* project differed also from the other two projects. Achieving an efficient project performance had required medium intensity levels of both communication and coordination.

Table 7-2: Actual communication intensity levels and performance

NPD project name	communication intensity level[40]	Performance[41]
Io Digital	High	High
ORA	low	High
Mistral	Medium	High

[40] Based on table 6-2

[41] Based on table 6-1

Table 7-3: Actual coordination intensity levels and performance

NPD project name	Coordination intensity level[42]	Performance[2]
io-Digital-Pen	High	High
ORA	Medium	High
Mistral	Medium	High

Based on the results of the case studies, I argue that the efficient performance of the development project is achieved only when the required intensity of communication and coordination is met (by the actual ones). The actual intensities in the three projects are matching with what proposed in the previous section (the shorter the DCT of the NPD project, the higher the required intensity of communication and coordination). Indeed, the output of meeting the required intensity of communication resulted in speeding up the decision-making, and making the strategic partners upstream and downstream aware of each other's functions and capability. On the other side, meeting the required intensity of coordination resulted in the overlapping of activities whenever needed, and reduced the amount of repetitive work to the minimum. Both outputs were essential to efficiently develop the NPD projects. Figure 7-5 shows the output of meeting the required intensity of communication and coordination with the project partners.

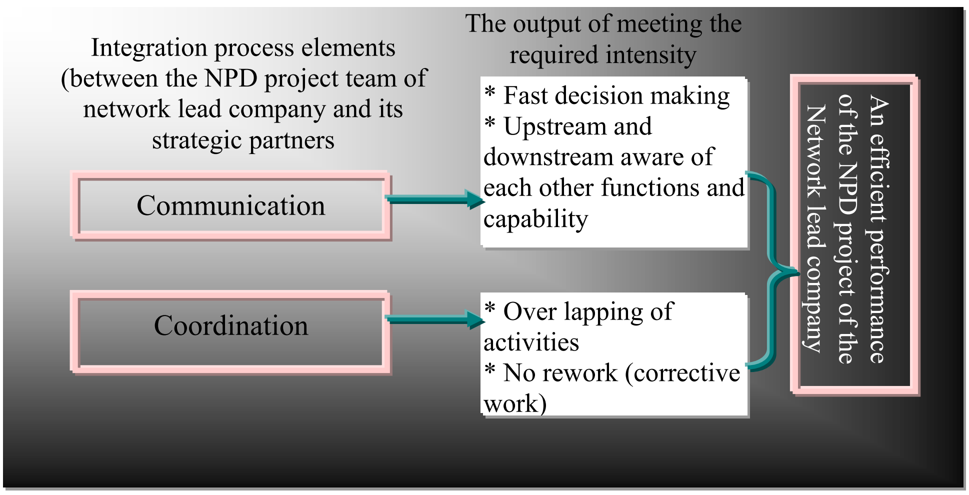

Figure 7-5: The output of meeting the required intensity of integration process elements

[42] Based on table 6-3

However, more or less intensity of communication and coordination between the project partners than what is required may result in negative effects. For instance, more intensity may lead to wasting time, efforts, and money in unnecessary activities, negatively impacting the project performance. Sherman (2004) stated that minimising coordination costs are primary considerations in organisational design decisions. Moenaert *et al* (2000) argued that, for the communication to be efficient, the intended communication effects must be obtained at the lowest cost possible. On the other extreme, less intensity than what is required may lead to a negative consequence as well. The literature is rich with research on the negative impact of lack of communication (Badir et al., 2003) and coordination (Browning, 1999; Souder & Sherman, 1993).

Indeed, it is not accurate to propose, as some researchers have had (Homans, 1974; Coleman, 1990; Ellickson, 1991; Hoegle & Gmuenden, 1998), that the higher the intensity of communication and coordination with the NPD project partners, the better the NPD project performance. It all depends on meeting the level of communication and coordination required by the NPD project. Thus, we propose the following:

Proposition 2:

The efficient performance of the development project (shortest, cheapest, and highest quality possible) is contingent on how well the actual intensity levels of communication and coordination match the required intensity levels. See Figure 7-6.

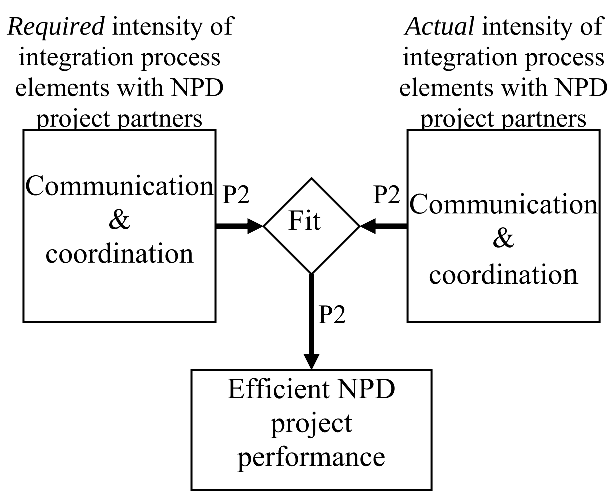

Figure 7-6: Required and actual intensity of integration process elements and performance

I found, however, some evidence from the literature supporting the finding of the case studies regarding meeting the required integration process elements intensity level to improve the NPD performance. For instance, Moenaert et al (2000) studied the communication flows in international product innovation teams within a firm. He concluded that the fit between communication requirements and the communication capabilities results in new product success. Gupta et al. (1986) stated that the needed coordination and control should meet the degree of integration achieved to increase the innovation success rate. Other theorist have made information processing that integrating or central concept in models that attempt to describe how organisations can match different technologies to the design and structure of units in order to achieve high unit performance (Keller, 1994; Cohen & Levinthal, 1990; Daft & Lengel, 1984; Galbraith, 1973; Nadler & Tushman, 1988). The basic notion of these models is that a proper fit between complexity of task technology and the information processing activity of an organisational unit will result in high unit performance. However, most of these works have mainly focused on within organisation activities. In addition, they did not take in consideration other project characteristics such as development cycle time. Bensaou and Venkatraman (1995) studied the interfirm relationships in automotive industry. The authors focused on interorganisational level of analysis and concluded that the information processing needs should fit the information processing capabilities in order to improve the performance. Gulati (1998) stated that prior research on alliances has focused on the firm or alliance as the unit of analysis. In this research, I adopt the NPD project level of analysis, and investigate how specific project characteristics influence the required intensity level of communication and coordination with the project strategic partners, and how meeting the required intensity resulted in improving the project performance. This level of analysis is very important as companies collaborating with each other to develop and bring new product to the market.

7.4 The relationship between the R&D organisational attributes and actual integration process elements

Section 7.3 has proposed that the efficient performance of the NPD project is achieved when the required intensity level of integration process elements with the NPD project strategic partners fit the actual intensity. The question that arises here is, *in the network lead company, which R&D organisation design would most likely enable the actual intensity level of integration process elements with the NPD project strategic partners*?

In order to answer the above question, I begin by investigating the relationship between the five organisational attributes of the R&D organisation in the network lead company and the actual intensity of integration process elements in short, medium, and long DCT projects, (Figure 7-7). However, in order to avoid repetitive work, propositions will only be developed for high intensity of communication and coordination; I assume the low intensity will just be the opposite, otherwise, I will indicate it.

In Chapter 6, I have identified the most important organisational attributes that have strongest impact on the actual communication and coordination with the NPD project strategic partners. These attributes are: decentralisation, formalisation, number of hierarchical levels, power of project leader, and the project team empowerment. I assert that these five attributes, analysed individually and together, constitute a fairly comprehensive characterisation of R&D organisational design.

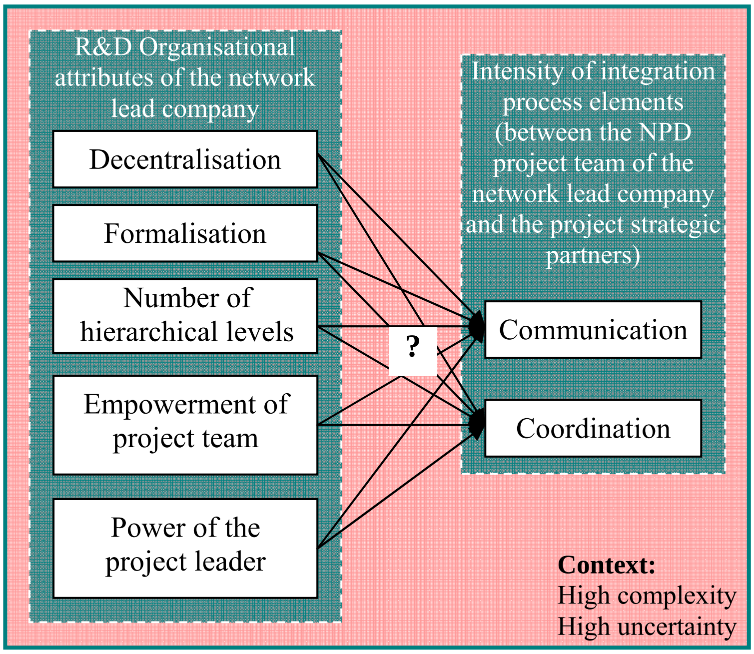

Figure 7-7: The relationship between organisational attributes and the integration process elements

The literature is still not consistent in answering questions such as which organisational attributes have the strongest impact on organisation behaviour. Different researchers use different attributes (Nohria & Ghoshal, 1997; Ichniowski & Shaw, 1999; Malhotra et al., 2001; Lukas et al., 2002; Strebel, 2003; Tomala & Sénéchal, 2004). However, I found some research supporting the five organisational attributes identified. Since the landmark studies of the Aston Group, centralisation and formalisation have become central constructs in the analysis of the structure in complex organisations (Pugh et al. 1969; Nohria & Ghoshal, 1997). Argyres and Silverman (2004) explored the link between a firm's organisation of reseach – specificall, its choice to operate a centralised or decentralised R&D structure – and the type of innovation it produces. Fry and Slocum (1984) used centralisation, formalisation and complexity to study the impact of organisational design on the effectiveness of workgroups. Other researchers (Charan, 1991; Kessler & Chakrabarti, 1996; Menon et al., 2002; Meyer, 1994; Pujari et al., 2004; Strebel, 2003; Tidd et al., 1997) argued for the importance of the number of hierarchical levels, project leader and the empowerment of teamwork as other primary structural attributes describing organisational characteristics.

7.4.1 Decentralisation and actual integration process elements

As mentioned in Chapter 6, decentralisation is defined as the degree to which decision making authority is pushed down to lower levels of the firm. The interest of Table 7-4 is to analyse the impact of centralisation of R&D organisation on the intensity of the integration process elements with the NPD project strategic partners. This table is based on results of the case studies summarised in Table 6-2, Table 6-3, and Table 6-5.

Table 7-4: Decentralisation and actual integration process elements

Company name	Decentralisation	Communication
Company-A	High	High
Company-B	Low	Low
Company-C	Medium	Medium
	Decentralisation	**Coordination**
Company-A	High	High
Company-B	Low	Medium
Company-C	Medium	Medium

The findings revealed that when the R&D organisation was low centralised, the intensity levels of communication and coordination with the NPD project strategic partners were high. The opposite was true for communication, but not for coordination. When the organisation was highly centralised, the communication intensity was low but the coordination intensity was medium. It seems that centralisation may not lower the coordination of activities with the strategic partners, but it does not necessarily raise it to high level.

As stated above, the short DCT of the *io-Digital-Pen* project increased the need for high intensity of communication and coordination between the project team of Company-A and its project partners' teams. The top management of the R&D organisation at Company-A did not want to be involved in these processes, as this could have overloaded it with decisions to be made not only regarding *io-Digital-Pen* project, but its other on-going NPD projects as well. An overloaded management may result in bad quality decisions; as there would be many decisions to be made in relatively short time, delay in the development activities due to vertical communication, and time wasted waiting for decisions to come from the top of the organisation.

Consequently, Company-A employed a decentralised structure in its R&D organisation and removed all barriers hampering the direct communication and coordination between its development team and the partners' teams. The company pushed down all the decisions that related to the NPD projects to where the actual development work was done. Indeed, the decentralised structure calls for decentralised communication between NPD project teams across the network. Decentralised communication patterns permit the efficient use of individuals as problem solvers, since these patterns increase the opportunity for feedback and error correction, and for generating and synthesising different points of view. Furthermore, because decentralised communication patterns are relatively independent of any one individual, they are less sensitive to overload or saturation than centralised patterns. Decentralised communication enabled the *io-Digital-Pen* project team of to better coordinate the execution of activities, manage work interdependence, and share resources with their strategic partners.

On the other hand, the low intensity of communication and coordination required between the *ORA* project team and the partners' team was enabled by a centralised management system. The top management of the R&D organisation at Company-B was deeply involved in the decision making regarding the development activities for the following reasons: i) There were relatively few decisions to be made on a monthly basis for instance, as the typical "unit-time" to execute tasks in this industry required longer time than other tasks in other industries. The top management will not be over helmed with many decisions to take; ii) The cost of the activities is quite high compared to other industries, and any mistake or incorrect decision made by project members may results in significant losses for the company; and iii) Due to the long DCT of the *ORA* project, the project was divided into three sub-projects; each with its own project leader and team. No one project team had a total view of the entire project. Because of this, incorrect decision may have a negative consequence on the total project. This example confirms that centralised structure is suitable when the required intensity of communication and coordination with the NPD project partners is low, but certainly not appropriate to handle a high intensity.

Based on the foregoing argument, I propose the following:

Proposition 3:
The decentralisation of the R&D organisation in the network lead company is positively related to the high intensity of communication and coordination with the NPD project strategic partners.

The impact of decentralisation on NPD project *within a firm* has shown mixed results in the literature, justifying the need for further examination (Alder et al., 1999; Gupta et al., 1997; Liden et al., 1997). The research of Fredrickson (1986), Fry and Slocum (1984), and Hall (1977) suggests that centralisation is expected to have a significant negative effect on the quantity and quality of information sharing between the technological functions and, therefore, on the integration and performance. If the communication flows between two functions are mediated through the top of the organisation, this is expected to result in a severe loss of awareness and appreciation of the other function (Moenaert et al., 1994). Decentralisation allows the organisation to respond quickly to local conditions in many different places. It can serve as a stimulus for motivation, since capable people require considerable room to manoeuvre if they are to perform at full capacity (Segal-Horn, 2002). However, it is difficult to conclude that centralisation has only a negative impact on an organisation. Some researchers argue that in some cases centralisation seems to be an effective way to manage (Sheremata, 2000).

Some researchers investigated the link between uncertainty and centralisation in NPD projects *within a firm*. Schoonhoven (1981) stated that in conditions of high uncertainty, decentralisation resulted in increasing effectiveness. When uncertainty was low, increased decentralisation and non-standardisation resulted in less effectiveness. As uncertainty increases, the volume of information required to execute activities increases. Centralisation must then be reduced so that the subunit and NPD managers and teams can communicate directly with their project partners to get the information they need. One of the most common findings in organisational theory is that the span of control of first-line managers decreases with increases in NPD project complexity and uncertainty.

As for NPD projects *across firms*, this research has differentiated between communication and coordination with external partners and project performance. The results of this thesis provide support for the use of a more decentralised management system to have a high intensity of communication and coordination with the project strategic partners. However, the results indicate also that high intensity will not necessarily improve project performance. It depends on the development process characteristics such as complexity, uncertainty, and development cycle time.

As I mentioned before, in long DCT projects where the intensity of communication and coordination is low, a focused organisation with a high degree of centralisation (control) will most probably lead to success. In short DCT, a certain degree of decentralisation and flexibility is essential to encourage the high level of communication and coordination that is needed to survive. The freedom to communicate and share knowledge is the key to success. What is needed in this case is a decentralised and looser control to provide more flexibility and encourage communication between NPD project teams across the network.

7.4.2 Formalisation and actual integration process elements

In this research, formalisation of R&D organisation is defined as the degree to which the organisation utilises rules, procedures, and written documentation to structure the behaviour of individuals or groups within the organisation. As with centralisation, a series of indicators was used to measure the degree of formalisation in the organisations examined, such as the existence of: comprehensive rules for all routine procedures and operations with regard to the R&D process; procedures to follow in dealing with arising conflict; written rules and procedures for the NPD process; and job descriptions for all the NPD activities. Table 7-5, presents the formalisation levels in the case studies. This table is based on Table 6-2; Table 6-3; and Table 6-7.

Table 7-5: Formalisation and actual integration process elements

Company name	Formalisation	Communication
Company-A	Medium	High
Company-B	High	Low
Company-C	Low	Medium
	Formalisation	**Coordination**
Company-A	Medium	High
Company-B	High	Medium
Company-C	Low	Medium

Unlike with centralisation, the research findings on formalisation are divided regarding its impact on communication and coordination intensity levels. The evidence from the case studies proves that formalisation has a negative relationship with communication, and an inverse u-shape relationship with coordination.

As shown in Table 7-5, the low and medium levels of formalisation of the R&D organisations are associated with medium and high levels of communication intensity, respectively, with the project strategic partners. However, high level of formalisation is associated with low level of communication intensity. In fact, formalisation could be seen as a disadvantage in uncertain, complex, and short DCT project. It promotes institutional inertia and an inability to respond rapidly and flexibly to changing external circumstances. A formalised structure comprising activities that are not core to the development process is likely to reduce the focus of the NPD project team on their main activities. Because of the time and effort they have to spend fulfilling the formal processes, this is likely to negatively affect the frequency of communication (face-to-face, video conferences, phone calls, and email exchange) and the flow of information and knowledge sharing between the NPD project team members of the network lead company and those from the project strategic partners. Although Moenaert et al., (1994) states that formalisation is expected to significantly increase the communication flows between marketing and R&D within an organisation, I postulate that it essentially impedes the flow of information between independent organisations, such as strategic partners participating in high-tech projects, and is therefore inversely related to improving communication between them

Conversely, in relation to the intensity of coordination activities (rate of resource sharing and amount of time and effort spent in managing activities interdependency) between the NPD project team members of the network lead company and those from their project partners, the data in Table 7-5 shows an inverse u-shape relationship between coordination and formalisation. As shown in Figure 7-8, when the formalisation level of the R&D organisation was medium, the intensity of coordination with the NPD project strategic partners was high. However, when the formalisation levels were high or low, the result was medium intensity of coordination.

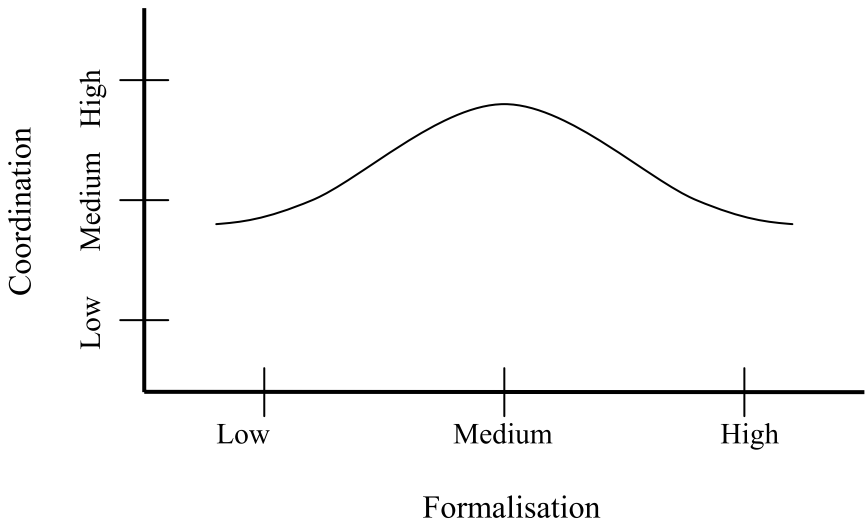

Figure 7-8: The inverse u-relationship between formalisation and coordination

Resource dependency theory, as developed by Aldrich and Pfeffer (1976), Pfeffer and Salancik (1978), and Olson et al, (1995), Medcof (2001), and Tillquist (2002) argues that the degree of interdependence among functional specialists and the nature of the interactions resulting from that interdependence are influenced by the characteristics of the collective task to be accomplished. The more complex, ill-defined, and difficult that task, the greater the functional interdependence and the flow of information and other resources across functional departments. This argument can be extended to a network of strategic partners, as is the case in this research. Interdependency and resource sharing with project partners means relinquishing control over one’s own activities and resources, which seems to be more or less an automatic consequence of close relationships. It also means that some of one’s own freedom is lost. The case studies reveal that the interdependence of activities and resource sharing were two of the most common reasons for conflict between partners. The situation was even worse in short DCT projects, where there were more resources to be shared and more activity interdependency to be managed within a relatively short period of time. The innovative organisation cannot rely on any high form of formalisation for coordination. At the same time, it cannot rely solely on informal structure.

The environment of high-tech NPD projects is uncertain, complex, and less predictable. The organisation structure of the network lead company should provide a way for the NPD team to coordinate the unplanned activities or events (e.g. emerging issues) with the partners. Although the unplanned and emerging activities may represent a small percent of the overall activities in the NPD project, any miscoordination may result in hazardous consequences. Highly formalised structure may help in coordinating the project's planned activities, but won't necessarily help in the unplanned activities. On the other hand, low formalised structure may work better in handling unplanned activities, but won't necessarily be efficient in handling the planned activities. A moderated level of formalisation of the R&D organisation in network lead company structure can be a way to overcome such problems. Thus, the following propositions are postulated:

Proposition 4a:
The formalisation of the R&D organisation in the network lead company is *negatively* related to the high intensity of communication with the NPD project strategic partners.

Proposition 4b:
There is an inverse u-shape relationship between the formalisation of the network lead company structure and the intensity of coordination with the NPD project strategic partners.

Proposition 4c:
A moderate formalisation of the R&D organisation in the network lead company is *positively* related to the high intensity of coordination with the NPD project strategic partners.

The formalisation impact on NPD projects' communication and coordination *within a firm* has been presented with mixed results in the literature (Gupta et al., 1986; and Menon, et al., 2002; Palmer & Dunford, 2001). Moenaert et al., (1994) stated that formalisation is expected to significantly increase the communication flows between marketing and R&D within a firm. On the other hand, Utterback (1994) found that flexible and less formalised organisations are associated with high lateral communication. Marsden et al., (1994) argued that the organisation formalisation is positively related to coordination of employees' work. Menon, et al. (2002) stated that high degrees of formalisation can make a firm rigid. If a firm codifies all of its activities with detailed resources, it may stifle employee creativity. Employees may not feel empowered or motivated to implement new solutions (Schilling, 2005). Mixed results were also reported on the impact of formalisation on performance. Organisations that are more formalised are reported in the management literature as performing better in more stable environments; by contrast, less formal, organic organisations perform better in less stable situations (Gupta et al., 1997; Bartlett & Ghoshal, 1995). But some operation management research literature has presented more formalised organisations as more efficient (Ichniowski & Shaw, 1999; Kelley, 1994).

As for the impact of formalisation on NPD projects' communication and coordination *across firm*, the analysis of the results in this research suggested that the formalisation of the organisation is negatively related to the high intensity of communication with the project strategic partners. Moreover, there is an inverse u-shape relationship between the formalisation and coordination with external partners. This is to say that high or low formalisation would have a negative impact on coordination of activities with the external partners. The findings suggested also that the formalisation has no direct impact on project performance. As the case with centralisation, the performance of the NPD projects depends on meeting the required intensity levels of communication and coordination with the external partners.

7.4.3 Number of hierarchical levels and actual integration process elements

As mentioned earlier in Chapter 6, the number of hierarchical levels refers to the number of management layers between the NPD project team and the head of the R&D organisation within which the NPD project is being conducted. This number is indicative in the layers through which the R&D director (highest level in the R&D organisation) gets information about the NPD project, and his decisions are communicated to the NPD project team. Table 7-6, shows the number of the hierarchical levels in the three case studies and the intensity of integration process elements with the NPD project strategic partners. This table is based on Table 6-2; Table 6-3; and Table 6-8.

The question this section tries to answer is, *for the network lead company, what number of hierarchical levels (few or many) is best for its R&D organisation to facilitate and support the integration process elements with the NPD project strategic partners?* The results of the cases show that limited number of management layers in an organisation has a positive impact on the intensity of communication and coordination. On the one hand, as shown in Table 7-6, in high complex and uncertain development projects, fewer hierarchical levels enables high or medium intensity of communication and coordination with the NPD project strategic partners. On the other, many management layers results in low communication and medium coordination. The cases show no evidence that the presence of many management layers may lead to high intensity of coordination with the strategic partners.

Table 7-6: Number of hierarchical levels and actual integration process elements

Company name	# of hierarchical levles	Communication
Company-A	Few	High
Company-B	Many	Low
Company-C	Few	Medium
Company name	**# of hierarchical levles**	**Coordination**
Company-A	Few	High
Company-B	Many	Medium
Company-C	Few	Medium

In all organisations, whether centralised or decentralised, there are situations where top management of the R&D organisation has to be involved in the development project to make decisions related to important matters facing the NPD project (e.g., strategic issues, changes in the market or customer demands, changes in competitors' situation, etc.). However, the reaction of top management in a tall organisation (many hierarchical levels) to issues happening down in the operational level is slower than that in a flat organisation (few hierarchical levels). In fact, the case studies show that the tall organisation tends to be time-challenged and bureaucratic. These characteristics may have a negative consequence on the communication and coordination with external partners in short DCT projects. I contend that a key aspect of short DCT project is the ability to respond to the demands of emerging conditions. I also argue that high intensity of communication and coordination with project partners may be negatively influenced by barriers such as hierarchical levels. In order to improve communication and coordination, it is necessary to have a flat structure, with few hierarchical levels. Organisations that are flat in structure are able to combat the viscosity in information flow that is so typical of hierarchical bureaucracies, and are able to coordinate activities and exchange resources. Consequently, the following:

Proposition 5:

The larger number of hierarchical levels of the R&D organisation in the network lead company is negatively related to the high intensity of communication and coordination with the NPD project strategic partners.

The above proposition seems inline with the literature regarding the impact of the number of hierarchical levels on NPD projects *within a firm*. Menon et al. (2002) study the impact of hierarchical levels on communication within a firm and indicate, there is no best organisational design. An optimal structure depends on the requirements of the task and the environment. However, for complex and uncertain environments, flat organisations appear to be superior in that they support and facilitate the rapid flow of information. Meyer (1994) suggests that most modern organisations, in their quest to improve the way they serve their customers, tend to move away from a 'tall' structure with 'many hierarchical levels' to a faster and flatter structure. Johnson & Johnson, for instance, has split its 83,000-employee bureaucracy into several flat functional units (Menon et al., 2002). A flat structure promotes ownership of tasks, eliminates redundancy, is responsive to change, facilitates creativity and innovation, is closer and therefore more responsive to the customer, streamlines processes, and empowers employees. Flat structures also provide fewer opportunities for advancement, put more responsibility and stress upon the individual, require skilled employees with experience, and reduce independent checks and controls (Malkinson, 2003).

On the one hand, a tall, hierarchical structure allows for categorisation of work, a predictable career and compensation ladder, and clear accountability. It also places a premium on experience. On conversely, it may be expensive, waste time, be resistant to change, be likely to promote self-importance, and increase bureaucracy of organisation. The protocols imposed by the many levels of a tall structure could severely impede information flow. Because the traditional tall organisational structure has an inherent tendency to make corporations massive, unwieldy, and sluggish, Charan (1991) emphasises the need to rethink its merits.

7.4.4 Team empowerment and actual integration process elements

As stated in Chapter 6, the empowerment of the NPD project team of the R&D organisation is defined as the freedom and ability of the core team to make and execute decisions that are critical to the operation or directions of their project. Among the indictors used to assess the degree of team empowerment was the extent to which team members: could select different ways to do their work; determine what and how things were done; feel a sense of freedom in what they do; and make choices independent of management. The results drawn from the case studies regarding the team empowerment are shown in Table 7-7.

Table 7-7: The team empowerment and actual integration process elements

Company name	Team empowerment	Communication
Company-A	High	High
Company-B	Low	Low
Company-C	Medium	Medium
Company name	**Team empowerment**	**Coordination**
Company-A	High	High
Company-B	Low	Medium
Company-C	Medium	Medium

The data in Table 7-7 shows that there is an associate between the empowerment of the NPD team and intensity of integration process elements with the strategic partners. When the degree of team empowerment was high, medium, or low, the intensity of communication was correspondingly high, medium, and low. As for coordination, when the degree of team empowerment was high or medium, the output was high or medium intensity of coordination with the NPD project strategic partners. Although a low level of team empowerment led to medium intensity of coordination, the cases provided no evidence that high empowerment of the NPD team may lead to low or medium coordination.

An important characteristic of the three high-tech NPD projects in this research was the large proportion of top-level professionals these projects employ. They held advanced degrees in a variety of professional fields. Empowering this type of team may result in improving the communication and coordination processes, since the team members will be willing to commit themselves to things that they have agreed to. In fact, empowering the NPD team to make project decisions gives its members a sense of ownership and control over their work, and they become more committed to project goals. The idea behind the empowerment of NPD teams in high-tech industry is to move resources and decisions as close as possible to where implementation actually occurs.

However, the advantages of empowering the NPD team to improve the communication and coordination with the project partners only work when the team members are responsible for the entire project, as is the case in the *io-Digital-Pen* project. In long DCT projects, such as the *ORA* project, where it was impossible to assign one team to execute the entire project, empowering the team members may have led to negative consequences because of the team having only worked on a part of the project (sub-project) without a sense of the entire project. Another reason for not empowering the *ORA* project team members was the cost of the tasks to be executed. The development tasks of biotech projects are very expensive compared to any other industries. Any inappropriate or incorrect decision may have significant financial consequences, with the loss of millions of dollars. This is particularly the case in the biotech industry. Based on this argument, I propose the following:

Proposition 6:
The empowerment of the NPD project team of the R&D organisation in the network lead company is positively related to high intensity of communication and coordination with the project strategic partners.

There is a considerable amount of literature supporting the importance of empowerment as a significant driver of project success *within a firm* (e.g. Anthony & McKay, 1992; Erikson, 2001; Forrester, 2000). The efficacy of empowering employees has overwhelming support in a long line of research in organisational behaviour and social psychology (Menon et al., 2002). The outcomes of empowerment programs are unequivocal and impressive. Conceptual analyses (Belcher & DiBlasio, 1993; Russo, 1985), laboratory experiments (Bandura & Wood, 1989; Erez et al., 1985), field studies (Jacobson & Ackerman, 1992; Larson, 1989), case analyses (Rabkin & Avakian, 1992; Sharp & Childs, 1992) and research reviews (Gowen & Jennings, 1990; Mabert et al., 1992) involving a multitude of work settings have repeatedly confirmed that when employees are accorded a sense of having power over their work environment, productivity improves significantly. Empowering a work team to quantify its own goals motivates members to be more committed to those goals than they would be if goals were simply decreed by a senior executive. Meyer (1994) recommends that managers be willing to relinquish some power so that employees can access and act on information traditionally reserved for managers.

General Electric found that a combination of empowered teams, flexible automation and computerised systems resulted in a 250% increase in productivity (Schilder, 1992). Similarly, instead of channelling decisions through sluggish bureaucracies, Four-Gen Technologies empowers its software engineers through a process called "down-streaming". These employees are placed directly "downstream" of their own decisions: they constantly interact with the company's sales teams and customers. Furthermore, they have ultimate responsibility for making appropriate product revisions. Empowering a team to make broad decisions gives its members a sense of ownership, which in turn results in improved performance (Donnellon, 1993; McCune, 1992). Levy (1998) stated that only by gaining a high level of employee commitment is an organisation likely to achieve the improvement it is aiming for.

Inline with the above mentioned literature, the results of this research suggested that the involvement of the top management in NPD project's decisions making may deeply affect negatively the project team and their communication and coordination with the project strategic partners. An organisation in which decision-making authority is not ceded to the development teams removes many of the learning opportunities from members of the project team, particularly the possibility of learning from mistakes. Less centralised organisations, by contrast, enable decision making to occur at the level of the project team. This improves employees' involvement in and commitment to a development project. This in turn may yield more communication and coordination with the project partners and shorter product completion times.

7.4.5 Power of project leadership and actual integration process elements

The team leader is responsible for directing the team's activities, maintaining the team's alignment with project goals, and serving as a communicator between the team and top management. In this research, the power of the project leader is defined as the extent to which the leader is able to make decisions related to the NPD project. Clark and Fujimoto (1991) have provided evidence of the importance of a powerful leader to the pace of a product development project. They used the term "heavyweight" to describe project leaders who report to high levels within the hierarchy, have high status within the organisation, and have direct responsibility for many aspects of the project. The power is in the ability to change another's attitudes, beliefs, or behaviour in an intended direction. The project leader is considered powerful if he made or participated in making decisions related to: appointment of some of the NPD project team members; type and brand of new equipment to be bought;

development costs; operations priorities; supplier selection; and number of people to be employed for the project. The extent of the power of the project leader in the three case studies is shown in Table 7-8. This table is based on Table 6-2; Table 6-3; and Table 6-12.

The analysis of the results shows a positive relationship between the power of the NPD project leader and the intensity of integration process elements. A high level of power is associated with high or medium intensity of communication and coordination with the NPD project strategic partners. The data provide no evidence that powerful project leader results in low communication and coordination with the partners. In a highly complex, uncertain, and short DCT project, the greater the communication and coordination effort needed between project partners, the greater the opportunity for differences and conflict; hence, the greater the power the leader needs to maintain integration and resolve conflicts.

Table 7-8: The power of the project leader and the integration process elements

Company name	Power of the project leader	Communication
Company-A	High	High
Company-B	Low	Low
Company-C	High	Medium
Company name	**Power of the project leader**	**Coordination**
Company-A	High	High
Company-B	Low	Medium
Company-C	High	Medium

Because the three NPD projects in this research were “new to the firm” projects, and of great importance for the organisation in that they may open new markets, the three organisations assigned project leaders that were capable, experienced, and trustworthy, and gave them all the necessary resources to efficiently manage their projects. In short and medium DCT projects, such as *io-Digital-Pen* and *Mistral*, the project leaders were responsible for the entire project, from concept development to product launching. They were the driving force, maintained project continuity as well as the integration of several internal and external functions, prospected and selected the necessary competencies, bridged the differences in time goals between the functions involved, and monitored and controlled the flow of information. Because R&D management recognised their importance, these characteristics and responsibilities provided the project leaders with positions of strength within their organisations, thereby giving them access to all the information and resources they needed.

As a result, project team members were able to get all information and resources they needed in a relatively short time. As was expected, this resulted in improving the communication and coordination with the project strategic partners. In fact, empowered team leadership is much more directly related to the team's communication and coordination than senior management. This is because the team leader interacts much more frequently with team members and influences their behaviour more directly.

With the *ORA* project, on the other hand, the project manager was mainly coordinating different functions involved in the project, and had limited power. His role was to achieve unity of control over project activities, with authority to control project matters and control expenditures, but no actual line authority over workers. Most necessary information and resources had to be requested from R&D top management. As is clear in table 7-7, this resulted in low intensity of communication and coordination with the project strategic partners. It should be noted that because the project performance fell within the range of what was deemed "successful" at Company-B, I argue that this type of project leader is appropriate for the long DCT projects, where the number of activities to be executed (monthly, for instance) is limited, and the unit-time to execute these tasks is very long. In addition, there is a low intensity of communication and coordination required between the development teams. Therefore, I propose the following:

Proposition 7:
The power of the NPD project leader of the R&D organisation in the network lead company is positively related to high intensity of communication and coordination with the project strategic partners.

The literature on the impact of project leadership on NPD projects *within a firm* is vast (Maylor, 2003). In spite of this, there is no single valid theory of leadership (Nicholas, 2001; Mullins 1999). However, earlier research has shown that the choice of the team leader is an important determinant of innovation success. Moenaert et al., (2000) stated that strong leadership often increases the transparency of the communication network because participants in the innovation project will use the team leader as the principal means for information diffusion. He also stated that the appointment of a "heavyweight" team leader lowers communication costs and improves information secrecy, network transparency, knowledge codification, and knowledge credibility in international product innovation teams.

Eisenhardt and Tabrizi (1995) stated that powerful leaders help to accelerate product development by keeping the process focused. Such a highly iterative and experiential process can lose its focus if the product team loses sight of the big picture. Conflicts and confusion can emerge. Powerful project leaders are essential to holding the product development process together. Such leaders accelerate the speed of product development by maintaining a disciplining vision that keeps the chaos of product experimentation under control (Brown & Eisenhardt, 1995a). Such a leader is also better able to secure the resources that the team needs to execute tasks. In a study of management in NPD units, it was found that the empowering manager is able to create an innovative climate most successfully (Frischer, 1993).

These types of project leaders are able to pull more power for their project and, as a consequence, more resources and information. However, Clark and Wheelwright (1993) and McDonough and Barczak (1991) stated that different types of teams have different leadership needs. For instance, while what may be described as “lightweight” teams might have a junior or middle-management leader who provides basic coordination between the functional groups, heavyweight and autonomous teams require senior managers with significant experience and organisational influence. This confirmed the last two propositions 6 & 7. In both, I suggest that empowered project teams and powerful project leaders are positively related to communication and coordination with the strategic partners.

The mentioned up propositions are incorporated in the preliminary model of the organisational attributes and its impact on integration process elements that developed in Chapter 3. Figure 7-9 shows a model of organisational design to support and facilitate integration process elements

7.5 Emergent model of the actual-required integration process elements and project performance

Figure 7-10 presents a contingent integration process elements model. The model emerges from the findings and uses the propositions as fundamental building blocks. The condition of fit between the required and actual intensity levels of integration process elements (between the project team of the network lead company and the NPD project partners’ team) is based on contextual conditions that characterise the high-tech NPD project, and the organisation of the R&D structure in the network lead company. Efficient performance of the NPD project will only be achieved when the actual intensity meets the required intensity.

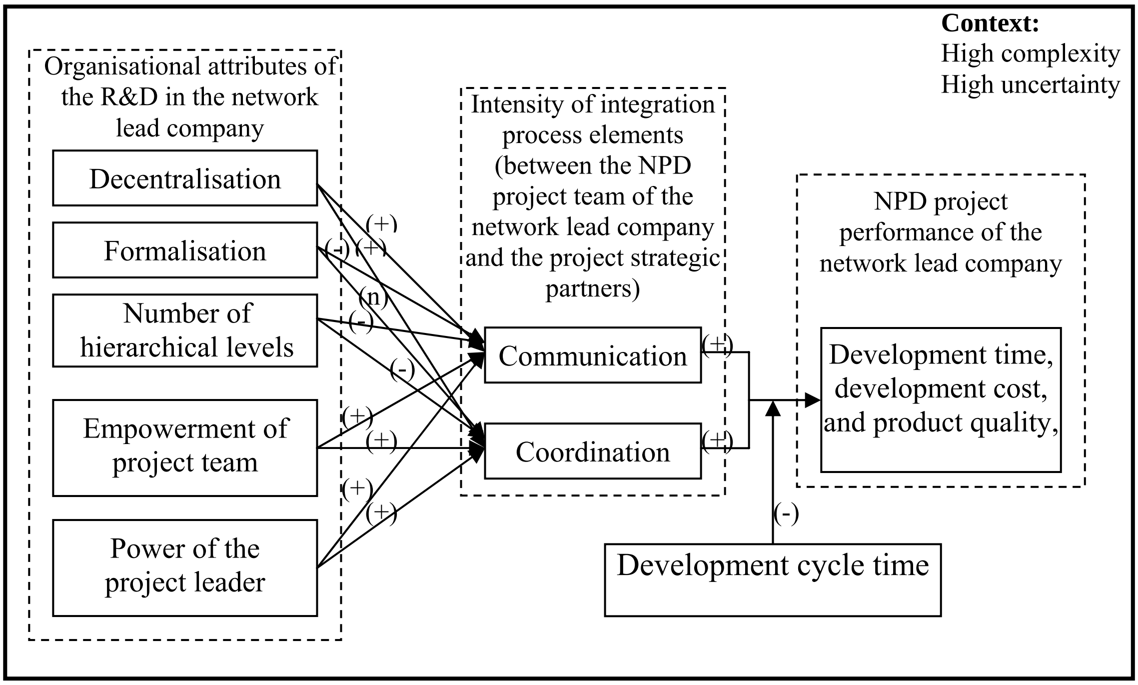

Figure 7-9: A model of organisational design to support and facilitate integration process elements

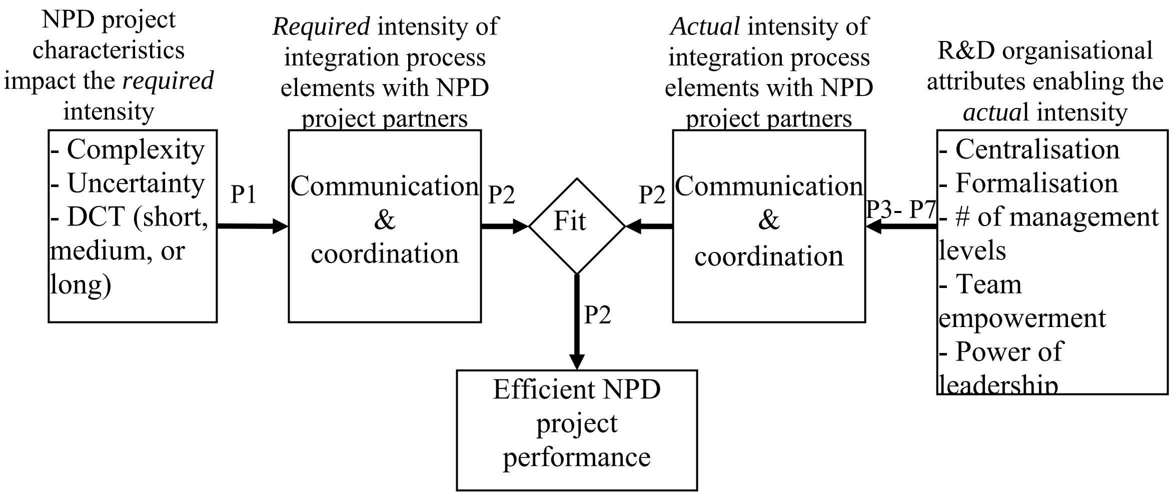

Figure 7-10: Emergent model of actual-required integration process elements and NPD projects performance in the network lead company

The seven major propositions which grew out of the data are summarised in Figure 7-11. It shows that the intensity of integration process elements and the organisational attributes vary along the continuum of DCT. As one moves toward short DCT, intensity of communication and coordination activities with the NPD project strategic partners required to achieve an efficient NPD project performance become higher, decision-making is more decentralised, rules and procedures are less formalised, hierarchical structure tends to be flatter, project leaders have more power, and project team members are empowered to make decisions related to their work. This combination of organisational attributes is often referred to as an "organic" structure in the literature, while the other end of the continuum, long DCT, is referred to as a "mechanistic" structure.

Integration elements & the supported organisational attributes	D.C.T	
	Short	Long
The fit intensity of integration process elements (required = actual)[43]:		
- Communication	High	Low
- Coordination	High	Medium
Organisational attributes supporting the fit intensity		
- Decentralisation	High	Low
- Formalisation	Medium	High
- Hierarchical levels	Flat	Tall
- Empowerment of project team	High	Low
- Power of project leader	High	Low

Figure 7-11: Organisation design to achieve an efficient performance of uncertain and complex NPD projects along continuum of DCT

This research demonstrates that high-tech innovative firms vary in their communication and coordination needs, from high intensity to low intensity. Moreover, unlike what organisational theorist used to think, these firms also vary in their organisational design, from very flexible "organic" to very rigid "mechanistic" structure. It depends not only on complexity and uncertainty, but also on the DCT of the projects. Consequently, I further categorised the high-tech organisations into organisation with short DCT and others with long DCT.

[43] As proposed before, the efficient NPD project performance is achieved only when the *actual* and *required* intensities of communication and coordination are matched.

The organisation theory is full of research suggesting that innovative and high-tech firms need to be flexible and organic to improve their performance (Utterback, 1994; Segal-Horn, 1998; Tatikonda & Rosenthal, 2000). Moreover, Schilling (2005) and Miles et al., (2000) stated that organic structures are often better for innovation and dynamic environments. Mintzberg et al., (1995) argued that the more complex an organisation's environment, the more decentralised its structure should be. He also argued that innovative organisations are highly organic, characterized by little formalisation of behaviour; specialised jobs based on expert training; a tendency to group the specialists in functional units for housekeeping purposes but an equal tendency to deploy them in small project teams to do their work; and considerable decentralisation to and within these teams. However, it should be noted that most of this research has focused on the integration of different functions and units within a firm, and not on the integration with external partners.

Two important research works, however, have already investigated networks of partner relationships, referred to as interorganisational relationships. The interest in this research is the fact that both were based on contingency theory. Nohria and Ghoshal (1997) investigated the relationship between the headquarters-subsidiary in multinational organisation (MNC). They stated that within an MNC, the various national subsidiaries are differentiated in terms of both the complexity of their environmental contexts and their local resource levels. Furthermore, depending on the nature of these contingencies, there is a fit structure of the headquarters-subsidiary relation that leads to improved subsidiary performance. However, Nohria and Ghoshal focused on firms that are organisationally dependent on each other (headquarters-subsidiary), and their structure design was not aiming at supporting communication and/or coordination between the partners. Moreover, the project level was not among their interests. Bensaou and Venkatraman (1995) studied the interorganisational relationships in the automotive industry. They focused on network level – without focusing on any specific organisation in the network – and developed a model of interorganisational relationships based on the fit between information processing needs arising from three types of uncertainty: environmental, partnership, and task uncertainties, and information processing capabilities that arising from three network structure mechanisms: structural, process, and IT mechanisms.

7.6 Conclusion

In this chapter, the results of the case studies have been analysed and discussed, and seven propositions developed. The chapter was organised into two main sections: In the first, the relationship between the integration process elements (communication and coordination) with the NPD project partners, and the project performance was explored; in the second section, I explored the relationship between five organisational attributes and the integration process elements.

Based on the analysis and discussion, I proposed a contingency model and developed a condition of fit between contextual conditions that characterise the high-tech NPD project and the organisation of the R&D in the network lead company. I argued that the NPD project context can be differentiated based on project characteristics: complexly, uncertainty, and DCT. The fit structure of the R&D organisation in the network lead company in each category is a correspondingly differentiated combination of the five organisational attributes: centralisation, formalisation, the number of hierarchal levels, team empowerment, and the power of team leadership.

The results demonstrated that the efficient development of an NPD project is only achieved when the *actual* intensities of communication and coordination between the project team of the network lead company and the project strategic partners match and fit the *required* intensity. The actual intensity is enabled by the five attributes of the R&D organisation. The required intensity is emerged from the project characteristics.

This contingent model resulted in developing different organisation designs to support and facilitate different intensity levels of communication and coordination with the project strategic partners, and improve the NPD project performance. In the next chapter the conclusion and recommendations arising from this research are presented.

8 Conclusion

This research has attempted to extend the knowledge of NPD process integration by proposing a contingency model and developing a condition of fit between contextual conditions that characterise the high-tech NPD project and the R&D organisation. The aim of the model is to support and facilitate the integration process elements – communication and coordination – with the project strategic partners. Using data collected from three in-depth studies of high-tech NPD projects conducted by three network lead companies from different industries, the research examined the impact of the R&D organisation in the network lead company on communication and coordination with the NPD project strategic partners, and the subsequent effect on project performance. Specifically, the research has tried to answer the question: *How can the network lead company design its R&D organisation to support the integration process elements with the NPD project strategic partners and improve project performance?*

Based on contingent theory and the case study findings, I argued that different industries required different intensity levels of integration process elements with the NPD project partners to efficiently develop new products. Moreover, different intensity levels of integration process elements are supported by different organisation designs. Consequently, two sub-questions were to be answered: i) *What intensity level of integration process elements does an NPD project team require with the project strategic partners to efficiently develop the product*? ii) *What R&D organisation design would most likely support and facilitate the required intensity level of integration process elements*?

The model suggested that the efficient performance of the development project (shortest, cheapest, and highest quality possible) is contingent on how well the ***actual*** intensity levels of communication and coordination match and fit the ***required*** intensity levels.

The research indicated that the ***required*** intensity of communication and coordination with the NPD project strategic partners in uncertain and complex project is dominated by the development cycle time (DCT) of the project. Conversely, the ***actual*** intensity of communication and coordination between the NPD project team of the network lead company and its project strategic partners is enabled (supported and facilitated) by differentiated combination of R&D organisation attributes. This research suggested five organisational attributes that have greatest impact on the actual communication and coordination with the project strategic partners: (1) centralisation; (2) formalisation; (3) number of hierarchical levels; (4) empowerment of project team; and (5) the power of the project leader.

The research showed that the intensity of integration process elements, and consequently the organisational attributes, varies along a DCT continuum from short to long. As one moves toward short DCT, the intensity of communication and coordination activities with the NPD project strategic partners that is required to achieve an efficient NPD project performance becomes higher. This research also pointed toward an R&D organisation design that most likely will enable the actual intensity to meet and fit the required “high-intensity” of communication and coordination with the project strategic partners. The organisational attributes used in this design are as follow:

- Decentralisation: The research suggested that decentralisation of the R&D organisation is positively related to the communication and coordination with the NPD project strategic partners. Decisions related to the development activities should be decentralised and pushed down to the operational levels where the actual work is done. The R&D management is involved only at specific times, such as “Go-gates” or when the project is out of track.

- Moderated formalisation: The evidence indicates that the formalisation of the R&D organisation is in inverse-u shape relationship with coordination, and a negative relationship with communication with the NPD project strategic partners. Indeed, using rules, procedures, and written documentation to structure the behaviour of the development team of the R&D organisation has two different implications for communication and coordination. Although moderated formalisation is positively related to the coordination of activities, it still has a negative impact on communication with the project partners. The management of the network lead company should trade off between these two important factors. A certain level of formalisation should be used in the R&D organisation to gain the maximum possible benefits from its positive impact on coordination while minimizing the negative impact on communication.

- Limited number of hierarchical levels: The case studies demonstrated a positive relationship between the limited number of hierarchical levels of the R&D organisation and communication and coordination with the NPD project strategic partners. Decisions from the head of the R&D organisation to the NPD team and information about the NPD project delivered by the team to the head of the R&D take place within a relatively short period of time. This may result in combating the viscosity in information flow that is so typical of a hierarchical, tall structure, and may also improve the coordination of activities and exchange resources.

- Empowered project team: The research recommended that empowerment of the NPD project team of the network lead company is positively related to high intensity of communication and coordination with the project strategic partners. In deed, the freedom and ability of the team to make and execute decisions that are critical to the operation and direction of their project has been shown to improve the interaction with the NPD project strategic partners' teams.

- Powerful project leader: This study suggested that the power of the NPD project leader of the network lead company's R&D organisation is positively related to high intensity of communication and coordination with the project strategic partners.

At the other extreme, as one moves toward long DCT, the intensity of communication and coordination with the NPD project strategic partners required to achieve an efficient performance becomes lower. Consequently, the R&D organisation becomes more centralised, with larger number of hierarchical levels; the project team is less empowered; and the project leader has less authority, with a moderated level of formalisation. Long DCT projects do not benefit substantially from the increased interaction, flexibility, and decentralised structure – at least, not enough to offset the higher time, efforts, and human resources costs typically associated with such structures.

8.1 Management implications

An organisation management that has a great understanding of its NPD project characteristics, and that effectively manipulates them to its favour, should have a competitive advantage in its development activities. In this research the R&D organisation design takes into consideration the characteristics of its NPD projects: complexity, uncertainty, and DCT. While strategy may be about competing and surviving as a firm, I argued that products, not corporations, compete, and products are developed through projects. Thus, the characteristics of a development project should be taken into consideration in designing the R&D organisation.

Most of the project characteristics (e.g., complexity, uncertainty, and DCT) that have a direct impact on the required intensity of communication and coordination with the NPD project strategic partners are beyond the control of the network lead company. However, the network lead company may manage those that are within its control to meet the required intensity developed from the uncontrollable factors, and tip the balance in its favour. By adopting an appropriate R&D organisational design, which the network lead company can obviously control, it will in all likelihood enable the actual communication and coordination to match and fit the required one. Thus, a firm has to deeply understand its NPD project characteristics in order to have a competitive advantage with its development activities.

Firms also have to find a balance between decentralisation and formalisation. Decentralisation of decision making from the top management to the lower levels is often accompanied by formalisation of the structure. Formalisation sets decisions premises, meaning that delegation involves less risk of losing control. Moreover, the degree of decentralisation is also associated with the cost and consequences of risk that the activity can have. The more expensive and risky the activities, the less decentralised the organisation.

The power of the NPD project leader is related to the importance of the project to the organisation. An NPD project that is of strategic importance to the firm is always led by a project leader who has a powerful position in the organisation. Moreover, in the planning phase of a complex, uncertain and long DCT project, when it's almost impossible to produce solid estimates of development time, cost, or even the quality of the final product, a firm has to assign a well experienced project leader. The longer the development cycle time, the harder estimation becomes. Companies in this case relied completely on the NPD project leader's experience.

In line with Allen Thomas's research (2006, 1989, 1986, 1977), which shows that distance has a direct impact on the communication between the team members within a firm, the three case studies reveal that the frequency of face-to-face meetings, which is the most important communication mechanism, and the rate of resource sharing increase when the partners are within close geographic proximity (same region, same country, same continent, etc.). To have better communication and coordination, it is useful to have partners who are situated, geographically, close to the network lead company.

8.2 Implication for theory

This study extends and merges the literature on NPD process integration, particularly across networks of strategic partners, and organisation design. In addition, it analyzes the links between organisational theory and innovation in general.

In the intrafirm context, there is a significant body of literature that investigates the impact of *internal* organisational design on innovation (Tidd et al., 1997), communication (Moenaert et al., 2000; Millson & Wilemon, 2002), and coordination (Sampson, 2005; Bailetti, *et al.*, 1994; Olson et al., 1995). However, in today's world where networks predominate, NPD projects frequently require the efforts and resources of multiple partners. Although several researchers have already highlighted the importance and influence of network lead companies (central companies) on network partners (Brass & Burkhardt, 1992), no research has been undertaken on the impact of the network lead company's internal design on the NPD project conducted jointly with strategic partners.

This research aims at filling the gap in the literature through its investigation of the impact of a network lead company's organisational design on the NPD project's communication and coordination with the project strategic partners. The journey of inquiry and discovery detailed above has led to several contributions to the knowledge base that may be summarized in the following manner:

1- Prior research into organisational theory has identified several organisational attributes that have impact on the communication and coordination within a firm. The list includes cross functional teams; interunit climate; the core team; and direct supervision (Moenaert *et al.*, 2000; Paashuis, 1998; Mintzberg, 1989). Within the context of interfirm relationships, I find no evidence from the case studies that supports these findings. It appears, for instance, that cross functional teams may improve integration within an organisation but have less influence on independent organisations. In this research, I identify the following primary organisational attributes having the greatest impact on communication and coordination with external partners: centralisation, formalisation, number of hierarchical levels, the power of the project leader, and team empowerment. The research also advocates different combinations of these organisational attributes when supporting different intensity levels of communication and coordination with external partners.

2- This research contributes also to the NPD theory by proposing a combination of two different mechanisms to integrate the NPD process, which I call integration process elements: communication and coordination. Historically, the literature has separated the two (Moenaert *et al*., 2000; Keller, 1994; Batt & Purchase, 2004; Bailetti *et al*., 1994; McChesney & Gallagher, 2004). Furthermore, this research goes beyond recommending integration process elements into supporting these elements by proposing a consistent set of organisational attributes. By linking the integration process elements to organisational design and to NPD projects carried out with strategic partners, I extend and deepen the theoretical foundations of these arguments.

3- Another key contribution of this research is the argument that the NPD project characteristics play a principal role in identifying the intensity levels of communication and coordination required between partners in order to efficiently development products. Prior research by Bensaou & Venkatraman (1995), Daft & Macintosh (1981), Thompson (1967), and Van de Ven & Ferry (1980) showed that communication, information processing, and coordination increase or decrease, depending upon the complexity and uncertainty of development tasks. In this research, I argue that there are other project characteristics that are equally as important as complexity. They are: DCT; number of tasks to be executed; time required to execute tasks; and the nature of task execution (parallel or sequentially). Finally, the research results demonstrate also that meeting the required intensity will prevent the waste of time, money, and efforts by the project team of the network lead company and those teams belonging to the company's project strategic partners. The result is an avoidance of unnecessary communication and coordination activities.

8.3 Limitation

As is usually the case, however, some potential limitations of this research should be explicitly acknowledged and taken into account when interpreting its findings. First and most critically, this research has focused only on the focal company in the network, and has aimed at understanding how a company in such a position can design its R&D organisation to support and facilitate communication and coordination with the NPD project strategic partners. There has been no attempt at investigating the strategic partners' organisations. Moreover, the scope of this research does not encompass investigation of the internal integration (within a firm) or strategic decisions, such as why a company partners with others or how to select partners, etc. Rather, this research is interested in delving into how to support such a strategic decision (the integration with the NPD project strategic partners).

Another concern with the current study is that this research has investigated three "new to the firm" projects. Because of time limitations, I could not include projects involving relatively familiar line extensions and product modifications. Thus, the model and propositions developed in this research might not work for other levels of innovativeness of products innovations.

It is to be noted also that this research has focused on the communication and coordination between the network lead company and its strategic partners, specifically those in whom the network lead company has equity investments. I believe that the level of communication and coordination that exists with equity-based partnerships is not the same as for non-equity-based partnerships; this is due to some organisational issues such as trust.

It's important to note that meeting the required level of communication and coordination with the NPD project partners does not always guarantee an efficient performance of the NPD project. As Clark and Fujimoto (1991) note, the performance of individual projects can be influenced by idiosyncratic factors, such as the abilities and personal characteristics of project team leader and members, unexpected changes in the competitive environment, fads, chance, and other circumstances, that may be difficult to duplicate from project to project (Ittner and Larcker, 1997). However, the model and propositions in this research will increase the probability of success for the NPD project, and minimize organisational factors that may present a barrier to the communication and coordination.

8.4 Future research

The present research focused on network lead companies developing high-tech products in collaboration with strategic partners. An interesting area for future research may be an examination of all partners' organisations participating in the NPD project. It is of great interests to see how different R&D organisations designs of different partners impact the communication and coordination activities along the NPD project. Such study may include different development cycle time high-tech and low-tech development projects, as to have different levels of complexity, uncertainty. Future research should aim at assessing the validity of the outcome of this research. It should, for example, be assessed whether the required intensity of communication and coordination between the network lead company and its project partners is the same for the other organisations that have non-central position in the network. Also, it should be assessed whether the factors that are dominating the required intensity of communication and coordination (complexity, uncertainty, and DCT) are also the most important for non-central organisation, or whether other factors become important.

Another area for future research will be longitudinal studies that trace a number of NPD projects conducted by strategic partners, from inception to dissolution. The study may carefully take into consideration the limitations of this research.

Finally, this research offers testable propositions that may advance NPD and organisation theories. As I argued before, no study has tested the impact of the R&D organisation of the network focal company on the integration process elements with the NPD project strategic partners. Thus, quantitative-based study testing these propositions will be useful. Although the five organisational attributes in this research were identified by the interviewees, I found that there was a strong correlation between centralisation, team empowerment, and the power vested in the project leader. I suggest that any future research on this topic group them under one construct in order to reduce the redundancy and the number of variables.

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Appendices

Appendix A: Interviewees and their role (from the three case studies)

Appendix B: Interview topics with the NPD project managers and coordinators

Appendix C: Interview topics with the R&D directors

Appendix D: List of professionals interviewed (outside the three case studies)

Appendix E: Excerpt from an interview with the io Digital Pen Project Manager

Appendix A: Interviewees and their role

(List of people interviewed in the three case studies)

Interviewee	Position	Company
Aldo Bussien	VP Engineering, Control Devices Business Division	Company-A
Yves Karcher	Retail Pointing Devices Business Unit Director	Company-A
Jean-Claude Etter	Digital Pen engineering project manager,	Company-A
Roger Roch	R&D and technology advisor, member of senior management	Company-C Group
Philippe Vogt	Project manager	Company-C Group
Lawrence Ganti	Corporate strategic planning	Company-B
Jon Lacy	Reproductive health pre-clinical and phase I development programs,	Company-B
John Delamarter	Head of research alliance management	Company-B

Appendix B: Interview topics with the NPD project managers and coordinators

1- General Project Description:

- What was the project: goal, size, starting date, date of completion, type of technology?
- What were the development project processes (or phases), and the approximate time for each phase?
- What were the project sources of ideas?
  * Internal sources: co-workers, internal R&D, marketing group, top management, manufacturing, etc.
  * External sources: users or customers, competitors, suppliers, private R&D, professional journals, consultants, cooperation with other companies, etc.

2- Partners: (the strategic ones)

- Who were the project main partners?
  * By business: (Users or customers, suppliers, university research centres, competitors, consultant, distributor, etc)
  * By size: (start-ups, SMEs, large)
  * By location: (local, national, international)
- Why those were the main partners, what makes the company interested in them?
- What were the partner selection criteria? (relationship, their technology, etc.)
- Do partners participate in the decision-making process?
- Is there any special arrangement for meeting or for communication with the partners?
- Do you share some resources and systems (e.g. database) with your partners? What are those resources?

3- Project Organisation:

a- What was the project organisation structure used? (e.g. matrix, functional, product group, customer type (military/civil), geographical area, etc.)

b- Project Team:

- What was the type of the team? (e.g. cross-functional changing with each new project, same team around projects, etc)
- What were the team backgrounds?
- How were the responsibilities distributed over the team?
- How was the team participation in the project decision making?
- What were the communication channels, formal and informal, between project members, members and leaders, members and external parties?

c- Typical management system:

- Can you tell us about the degree of formalization in the project (e.g. degree of bureaucracy, standardised jobs, a lot of rules and regulations, etc.)
- Can you tell us about the degree of centralisation in the project (e.g. is the decision-making authority centralised around one group or decentralised to many units, degree of top management involvement in decision-making, vertical communication, attention to ranks, etc.)

d- What role the project leader plays in the project (e.g. a strong and responsible project leader, full commitment to the project, coordinating, etc.)

4- Coordination Issues: internal and external (with the partners)

- In which project phases were the communication between members more intensive? And why?
- Do the project members have a shared view of what needed to be coordinated?
- How do you measure the interaction between project members? Is it through the frequency of communication between them? Or the content of the communication?
- What were the significant coordination –related problems encountered?
- What were their impact on the project in terms of unanticipated cost and time delays?
- What were the project management tools (IT, management models, etc.) used in the project to facilitate the coordination? And why?
- How do you manage the conflict between project members (either internal or external)?

5- Performance Measurement:

- How do you know if a project is a success or not?
- What factors would you use to evaluate projects? And why?

Appendix C: Interview topics with the R&D directors

I- Organisation of the R&D Activities:

- What are the typical activities and phases in this R&D department?
- What is the organisational structure of the R&D dept.?
- What are the typical back grounds of the management team of the R&D dept.?
- What are the main departments or division that the R&D is interacting with inside the company?
- What is the typical management system:

II- Partnership:

- Who are main partners (who the R&D is working closely with)?
  * By business: (Users or customers, suppliers, university research centres, competitors, consultant, distributor, etc)
  * By size: (start-ups, SMEs, large)
  * By location: (local, national, international)
- Why those are the main partners, what makes the company interested in them? How important they are for your business?
- Is there any type of organisational structure link Company-A with its partners?
- What were the partner selection criteria (relationship, their technology, etc.)?
- What type of relationship does Company-A has with its partners? Is there any investment Company-A made in their partners?
- Do partners participate in the decision-making process?
- Is there any special arrangement for meeting and communication with the partners?
- Do you share some resources and systems (e.g. database) with your partners? What are those resources?
- Is it important for Company-A to know the suppliers of their suppliers? Do Company-A has any relationship with them?

III- Coordination and Communication Issues: internal and external (with the partners)

- In which R&D phases are the communication between members and/or units more intensive? And why?
- Do the R&D members have a shared view of what needed to be coordinated?
- What do you share with your external partners (e.g. vision, strategy, business, etc.)?
- How do you measure the interaction between R&D members and the partners? Is it through the frequency of communication between them, the content of the communication, face to face meeting, etc.?
- What are the significant coordination –related problems encountered?
- What are their impact on the R&D projects in terms of unanticipated cost and time delays?
- What are the project management tools (IT, management models, etc.) used in the R&D Dept. to facilitate the coordination?
- How do you manage the conflict between R&D members (either internal or external)?

IV- Performance Measurement:

- How do you know if your R&D project is a success or not?

What factors would you use to evaluate projects? And why?

Appendix D: List of professionals interviewed

(This list does not include people interviewed in the three case studies)

Note: All the interviews were conducted by face-to-face meeting.

No	Interviewee	Position	Company name	Industry	Website
1	Dr. Maximilien Murone	Chief Operation Officer	Apotech	Biotechnology	www.apotech.ch
2	Dr. Davide Mauri	Chief Scientific Officer	Apotech	Biotechnology	www.apotech.ch
3	Dr. Dikran Antreasyan	Account Manager	LeCroy SA (Swiss subsidiary of LeCroy Corp based in USA	Electronics	www.lecroy.com
4	Mr. Mark Conoley	Manager	Tetra Pak International SA	Carton packaging solutions for food	www.tetrapak.com
5	Nicolas Bürki	Project manager	Calvin Klein Watches (Swatch Group)	Watches manufacturing	www.swatchgroup.com
6	Leo Focketyn	Head of Logistics Projects	Swatch Group Distribution	Watches manufacturing	www.swatchgroup.com
7	Zoubaier Mejri	Business Analyst and project leader	British American Tobacco	tobacco manufacturer	www.bat.ch
8	Dr. Anisa Bader	Regulatory Affairs Officer	Novartis Consumer Health	Pharmaceuticals	http://www.novartis.com/
9	Adel Mammer	Logistics project manager	Novartis	Pharmaceuticals	http://www.novartis.com/
10	Dr. Martin Luggen	Project Manager	Sanofi-Synthélabo SA	Pharmaceuticals	http://en.sanofi-aventis.com/
11	Joelle Kobza	Coordinator	Swatch Group	Watches manufacturing	www.swatchgroup.com

Appendix E: Examples of organisational attributes mentioned by the interviewees

Organisational Attributes	Excerpts from different interviews
	An interview at Company-A
Decentralisation of idea generation	……. However, the NPD process at Company-A starts by generating ideas. These ideas can come from different sources such as the product unit team, the engineering team and the marketing team. Any member in the company could participate in this phase. The ideas are mainly influenced by the market needs, competition, trends and technology. The product unit team will select an idea for further investigation.
Empowerment of the NPD team	….. Well, I can say that the development team at Company-A holds a full responsibility of the whole NPD project. The top management involves only in three gates. In the first gate (gate 0) the mandate is go and investigate the new idea. Once the team members receive the permission, they do all what they think it is important or useful to the project. Then in the next phase the top management involves again in "Go Gate" phase. The mandate here is go and develop the project. Again, once the development team members receive the approval, they start the development phase of the new product.
Power of the project leader and decentralisation of the organisation	….. Once the NPD project has been accepted, the project manager is able, to a large extent, to make decisions related to the NPD project. At Company-A, it's widely accepted by the top management that the project manager will take important decisions, which reflects the decentralised management style employed at the company.
Semi formalised	Company-A has implemented a simple but rigorous process to steer its product creation projects that typically lasts from six (for product extensions) to eighteen months (for totally new products). This process gives a lot of day-to-day freedom to the project teams, but it requires

NPD process	them to prepare for, and pass, three tough management reviews, or "toll gates," before commercial launch. These gates are passed in the course of animated meetings attended by the business and product unit heads, R&D director, as well as senior engineering and marketing mangers. These people are known at Company-A as the NPD management committee.
Empowerment of the development team	…. I think that the culture which is prominent at Company-A gives the NPD team members the freedom and ability to make and execute the decisions that are critical to the operation or direction of their project. The NPD team members at Company-A experience substantial freedom, independence, and discretion in their work. The team members are able to select different way to do their jobs and to make choices without being told by the manager to do so
Informality	… As I indicated before, Company-A encourages open and informal discussion, and free exchange of opinions. This could be a source of conflict between different people involved in the project. Company-A has no clear rules or procedures to solve conflicts between people. Although the company has developed a manual for responsibilities and decision making (who decides what), it was not compulsory for the people of Company-A to follow. Solving such conflicts may require the involvement of the top management.
Team empowerment and the power of the leadership	In the io Digital Pen project, the project manager and his development team participated actively in selecting the project partners. As stated before, most, if not all of Company-A products are developed in partnership with other companies. These partners were completely selected by the project manager and his development team.
	An interview at Company-B
Centralisation	….. Pharmaceutical companies responded to these circumstances by ruthlessly challenging the success potential of products and compounds through centralised decisions-making at the top management level and, recognising the logistical difficulty of managing scientists around the world, attempting to leverage the next generation of products by

	coordinating far-flung R&D activities. Ultimately, the major challenge for managers continued to be to mediate the legendary conflicts between R&D, production, and marketing.
Formalisation	At Company-B, there is a standard process for managing the development projects. This management process is well documented, and shows what input required from the team, what resources needed, how much time and cost for development, what documents and information the team have to present to get the approval from the top management.

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FIELD OF PROFESSION:

Management and implementation of technology projects, coordination of large-scale cross-industries development projects, high-tech organisation design

EDUCATION

2006	**PhD in Management of Technology.** College of Management of Technology, EPFL	Lausanne, Switzerland
2005	**Visiting Scholar at New York University** (summer semester).	New York, USA
2000	**Master in Logistics and Supply Chain Management**, EPFL	Lausanne, Switzerland
1996-1998	**Master of Science in Project Management**, University of Putra Malaysia (UPM), *Graduated with a GPA of 3.58/4.0*	Kuala Lumpur, Malaysia
1989-1993	**B.Sc., Civil Engineering**, a major in Project Management Civil Engineering Department, University of Garyounis,	Benghazi, Libya

PROFESSIONAL EXPERIENCE

2001- Present ***Research Associate*** Lausanne, Switzerland

Employer: College of Management of Technology - EPFL

Projects & Responsibility:

***A- LSB Project*:** supporting the communication and coordination of new product development projects with external partners. Project's key partners: Logitech (electronics), Serono (biotechnology), and Bobst Group (mechanics).

***B- ANAISOFT B2B Project*:** led and coordinated the development of a web-based system for managing global large-scale projects, and developed the business process management model and the data flow. The project was funded by The Swiss National Science Foundation (SNF). The project was rated by SNF as one of the two best out of a group of six.

C- 3C Project: I acted as a consultant for two biotech start-ups, developing a methodology that enabled them to select strategic partners and to integrate their development process with those partners.

1996-1998 ***Research Assistant*** KL, Malaysia

***Employer*:** Housing Research Centre, Malaysia

Project & Responsibility: ***Inno-Bil project:*** I controlled and analysed the work performance and worker productivity in terms of cost, time, and quality of innovative building systems.

1993-1996 ***Project Engineer*** Benghazi, Libya

***Employer*:** El-Amara Consultant Eng.,

Projects & Responsibility: I was responsible for coordinating the site activities of the following two large-scale projects:

***A- SO&M Project*:** The construction of Support, Operation and Maintenance (SO&M) facilities for the Great-Man Made River project (a Libyan national project; 20 billion $US).

B- Project of Sidi Sayah reservoir (Tripoli, Libya): Construction of reservoir with a capacity of 200,000 m^2, executed by contractors from Germany and S. Korea.

LANGUAGES AND COMPUTER SKILLS

Languages: Arabic, English, and French (intermediate)

Computer Skills: Microsoft Office, MS-project management, SPSS, "ProFlow" work flow management system.

VARIOUS

Publication	15 articles in several international journals, conferences and a book. One of them has been recognised by IEEE USA Today's Engineer among the engineering works of value in 2003.
Activities and Service	- The president of Civil Engineers voluntary group for community service – Libya (94/95). - Project leader for the final year student research, faculty of Civil Eng., University Putra Malaysia (1998).
Professional Affiliations	- Assoc. member of the Engineering Management Society (IEEE). - Member of Academy of Management Association (AoM). - Member of Strategic Management Society (SMS). - Member of Project Management Institute (PMI)
Hobbies	Swimming, tennis, and horse riding